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USE OF BIOGRAPHICAL INFORMATION ON STUDENTS WHO DO AND DO NOT ACHIEVE IN HIGH SCHOOL SCIENCE COURSES.

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A RELIABILITY ASSESSMENT WAS MADE OF A SELF-REPORTING INSTRUMENT WITH RESPECT TO ITS PREDICTIVE VALIDITY FOR SCIENCE ACHIEVEMENT. THE PURPOSES WERE TO DETERMINE IF--(1) SELF-COMPILED BIOGRAPHICAL DATA ARE REPRESENTATIVE OF ONE'S ACTUAL EARLY EXPERIENCES, (2) SCIENCE ACHIEVEMENT DEPENDS ON ONE'S SPECIFIC EARLY EXPERIENCES OR ON THE ENVIRONMENT IN WHICH THESE EXPERIENCES TAKE PLACE, AND (3) EARLY EXPERIENCES WHICH RELATE TO SCIENCE ACHIEVEMENT CAN BE RELIABLY MEASURED FROM SELF-REPORTED BIOGRAPHICAL INFORMATION. THE FIRST PROJECT PHASE CONSISTED OF ADMINISTERING THE BIOGRAPHICAL INFORMATION BLANK (BIB) TO ABOUT 550 HIGH SCHOOL SENIORS. PARENTS OF THESE SUBJECTS WERE ADMINISTERED THE PARENTAL ATTITUDE RESEARCH INSTRUMENT FOR CROSS-CORRELATION WITH THE BIB RESPONSES. THE SECOND PHASE EXPLORED THE RELATIONSHIP OF BIB RESPONSES TO THE SUBJECT'S ACADEMIC ACHIEVEMENT IN SCIENCE COURSES. THE RESULTING DATA WERE SUBJECTED TO FACTOR ANALYSIS. BIOGRAPHICAL INFORMATION ON THE BIB WAS FOUND TO BE A POWERFUL PREDICTOR OF ACHIEVEMENT IN HIGH SCHOOL SCIENCE FOR BOTH ORIGINAL AND CROSS-VALIDITIES. THE RESULTS SUGGESTED THAT SELF-RATINGS ARE IMPORTANT IN EVALUATING STUDENT CHARACTERISTICS, INCLUDING PERFORMANCE, AND IN SOME CASES EVEN MORE IMPORTANT THAN STANDARD TESTS AND SCHOOL GRADES. (RS)

Use of Biographical Information on Students Who Do and Do Not Achieve in High School Science Courses

Cooperative Research Project No. 1107

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CHAPTER I

Discussion of the Problem and Research Objectives

The search for competence, and especially for persons with high creative potential and scientific ability, is gaining momentum in many fields and at many levels of training and work. This is seen not only in the worlds of science and business, but also in recent growth in the size and number of scholarship programs. A consequence of this trend is that there is an ever increasing need to re-examine and re-evaluate the instruments, procedures, and data which are being used in the selection of persons of competence, and to explore alternative procedures for selection. This is especially crucial in view of the fact that some psychologists and administrators are becoming increasingly critical of the validity and relevance of many tests currently used in selection. For example, recent research on the _Medical College Admission Test_ suggests that it has only slight validity for predicting medical school performance (Richards and Taylor, 1961; Gough, Hall, and Harris, 1962) and may have _negative_ validity for predicting performance as an intern (Richards, Taylor, and Price, 1962). Yet this test is routinely administered to all applicants to American medical colleges and undoubtedly enters strongly into selection decisions.

It is a truism among psychologists that if you want to know something about a person one of the best ways to find out is simply to ask him. In spite of this, self-reports have been relatively neglected as a source of data for selection purposes. Probably the primary objection to self-reports is that it is believed that they can be easily faked. It is unquestionably true that it is not difficult to give a favorable picture of oneself on some self-reports. However, it is possible to construct self-report instruments (such as the MMPI) which are difficult or impossible to fake without detection. In addition, even for self-report instruments where the socially desirable answer is quite obvious, it is much less clear that faking does, in fact, occur frequently enough to invalidate self-reports as a measuring device. Dr. John Holland (personal communication) has reported that a simple self-rating form is among the best predictors in the intense competition for National Merit Scholarships, where participants have very strong incentives to present themselves as favorably as possible. It appears, therefore, that the possibility of faking should not be made the basis for rejecting a priori self-reports as an assessment device. The authors, therefore, believe that the use of self-reports in prediction and selection is a most promising area for investigation. Accordingly, the research reported here is concerned with the usefulness of one type of self-report instrument, a biographical information blank, for predicting achievement in high school science.

No study has been found in the literature dealing with the specific problems involved in the present investigation. This is a surprising state of affairs, since in spite of the relative neglect of self-report instruments in selection, there have been a fairly substantial number of studies indicating promise for the use of biographical information in the prediction of a wide variety of criteria. The use of biographical information blanks as a formal prediction device appears to have been initiated by Goldsmith (1922), Kornhanser and McMurray (1941), and Kurtz (1942), who used such a blank successfully to predict performance of salesmen. Ohman (1942) also was able to develop a weighted key for an application blank which was relatively successful in predicting good performance as a building material salesman.

Bitner (1945) investigated the use of a biographical information blank administered to high school students for predicting college attendance or non-attendance. This was a thirty-three item biographical blank covering such factors as the characteristics of the home and family, and occupational or educational plans. Two years later criterion groups of those who entered college and those who did not were established. A correlation of .54 with the college entrance criterion was found for eight items which predicted college performance as well as the total 33 items.

Hansen (1950) studied the relationship of an 120 item biographical blank to the academic and behavioral adjustment of high school boys. The criterion of behavioral adjustment was derived from teacher ratings, and the academic criterion was derived by converting both grade point averages and IQ's to normalized standard scores (Guilford, 1956), and then subtracting the converted IQ score from the converted grade point average. Positive differences were interpreted as over-achievement and negative as under-achievement. Cross-validities in the sixties were obtained for the behavioral adjustment criterion, and in the forties for the academic criterion.

Several studies have shown that biographical blanks are useful in predicting academic performance at the college level. Sorenson (1950) used an empirically keyed biographical blank to predict first quarter grades, and obtained a cross-validity of .36. Siegel (1956) found that four scales (Action, Heterosexual Activities, Political Activities, and Dependence Upon the Home) of a ten scale biographical inventory correlated significantly with college grade point average. Kausler and Little (1957), using the same inventory, obtained somewhat similar results using as the criterion grades in psychology courses.

More important for the present study, biographical information has shown substantial potential as a predictor of the performance of adult scientists. Stein (1956) and Roe (1951, 1953) have both reported life history data for scientists which indicated as a basic factor in success in science a feeling of apartness from others which took different forms and which seemed to have a number of different causes; i.e., childhood feelings of isolation, a pattern of general avoidance of intimate personal contacts, a considerably later than usual development of heterosexual interests (or at least of their expression), and even in adult life a decided preference for a very limited social life. The most important studies of the relationship between biographical information and the performance of adult scientists is found in the work of Ellison (1960), Ellison and Taylor (1962), and Taylor et al. (1960). These studies have used techniques virtually identical with those used in the present research, working with samples of physical science graduate students, Air Force scientists, and NASA scientists. In those samples, original validities for empirically derived biographical keys have ranged from the seventies to the nineties, and cross-validities from the forties to the sixties against a wide variety of criteria of creativity and productivity in science.

Objectives.

Due to the more and more difficult problems facing our society (e.g., the competition with Russia and the population explosion), it is increasingly important to discover persons with high potential for science at an early age, and certainly no later than the senior year of high school. While the above studies show a strong relationship between biographical information and the performance of adult scientists, none of them have explored the early identification of scientific talent,[1] and similarly have not determined whether or not biographical information is also strongly related to more intermediate criteria of scientific performance, such as grades in science courses.

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[1] At the present time, however, Dr. Calvin W. Taylor is exploring the role of biographical information in predicting the performance of high school students in NSF summer science programs. Also, Needham (1962) has constructed a biographical blank which predicted intelligence, tested creativity, and teacher preference in a high school sample. The creativity and intelligence keys were found to hold up under cross-validation.

The primary purpose of the present research is to begin to correct this deficiency by determining to what degree achievement in high school science can be predicted by a biographical blank, and to what degree the biographical blank is improving on the predictions of a conventional intelligence test. A secondary goal of this project is to explore also the processes involved in high achievement in high school science.

Another goal of the present research grows out of the fact that, in previous studies, biographical information blanks have been used on a trial-and-error basis, with little systematic investigation of the variables involved. Yet, the kind of inferences that can be made from the biographical correlates of a given criterion are crucially dependent on an understanding of what characteristics are involved in the biographical information blank. Therefore, the present project includes a first study of the kinds of inferences that can be made from a biographical blank. Specifically, the problem considered is the extent to which it is possible to make inferences from a given person's biographical blank responses to his parents' attitudes toward various child-rearing practices, or, in other words, the extent to which it is possible to make inferences about the general "climate" of the home in which that person was raised.

In summary, the three major objectives of this study as specified in the original research proposal were:

1. Determine if responses to biographical information blanks represent with reasonable validity the actual early experiences of the person who filled in the blank, or if in fact they more nearly represent systematic distortions of these early experiences. This is seen as a crucial question which determines the kinds of inferences which can be made from biographical information.
2. Determine if achievement and nonachievement in science courses among students depends on specific early experiences, or upon more general characteristics of the "climate" in which their early experience took place. This question is crucial to theoretical interpretations of the effects of early experience on special abilities and interests, and would be most important in the generalization of the results of this study to other courses and curricula than science.
3. Determine what significant differences there are in the early experiences of students who do and do not achieve in science courses which can be reliably measured through use of a biographical information blank. The answer to this question is crucial in the actual development of biographical inventories as an aid in the early detection of scientific potential.

CHAPTER II -A

The Biographical Information Blank in the Prediction of Four Indices of Achievement in High School Science

The first step in this project was to determine to what degree the Biographical Information Blank could successfully predict four basic indices of achievement in high school science. The basic procedure was to determine which specific biographical items are correlated with each of these indices, and from this information to develop empirical keys for predicting each index, or criterion. Since there is no doubt that such a procedure produces very high correlations if the key is "validated" on the same group on which that same key was built (Cureton, 1950), the validity of these keys was evaluated in a double-cross validation design. Two analyses of these criteria were made, one of achievement without regard to "ability" and one of achievement with "ability" controlled.

The Biographical Information Blank. The primary reason for the success of biographical information blanks as predictive devices appears to be that such blanks sample very broadly from diverse realms of behavior and attitudes. Thus, a chief distinction of the biographical information blank is that it tends to minimize the expression of general attitudes or response sets. Such a broad sampling also tends to minimize the influence of incorrect a priori hypotheses about what kinds of biographical information should be related to achievement. Accordingly, the goal in constructing the blank for this study was to sample very broadly. The result, of course, is an extremely heterogeneous group of items.

The Biographical Information Blank used in the present research is composed of 300 multiple choice items.[2] The items basically fall into four broad categories: (1) Demographic Information, (2) Early Life Experiences, (3) School Accomplishments, and (4) Current Attitudes and Achievements.

"Demographic Information" consists of highly objective background data. Questions such as "How old are you?", "How many odd jobs, part time or full time, have you held?" and "How old was your mother when you were born?" would be included. Items such as these remain relatively free of subjective attitudes and could be verified by independent sources if necessary.

"Early Life Experience" items attempt to reconstruct the child's perception of his relationships with his parents, siblings, and peers as well as their relationships with one another. "To whom did you feel closest during your childhood?", "How much disagreement, discord, or friction have you had with your mother?", and "Which of your parents is more to blame for the disagreements between them?" are examples.

"When you prepared for an exam, how often did you 'cram' instead of using other study methods?" and "About what percentage of students would you have surpassed if you had done the very best you could during your high school career?" are representative of the "School Accomplishments" category.

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[2] The authors wish to express appreciation to Dr. Calvin W. Taylor and Mr. Robert Ellison for permitting use of their biographical blanks as an aid in the development of the form used in this study.

The "Current Attitudes and Achievements" section includes miscellaneous items relating to future plans, ideals, values, and general habits. Questions ranging from "How often do you generally watch television at home?" to listing Money, People, Ideas, and Things in order of their importance, are representative of the range of items which are included.

The questions were designed so as to be applicable to both male and female high school students. Items with similar content were randomly distributed throughout the questionnaire in order to prevent the formation of an irrelevant response set, and thus allow each item to be responded to independently.

Subjects. The sample consisted of 543 students at two high schools in a suburban Salt Lake City, Utah school district.[3] These students were selected on the basis of having completed at least two science courses beyond general science, and were seniors at the time of the data collection. Of this sample, 331 students were tested in the winter and spring of 1961, and 212 students in the spring of 1962. There were 285 males and 258 females in this sample.

In obtaining these groups, a graduate assistant went to the permanent school records and obtained the names of all students who

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[3] The authors are grateful to Dr. Kenneth C. Farrer of Granite School District for making this sample available.

had completed the required number of courses. Arrangements were then made to test these students in groups through the school counselors. All testing was done during regular school hours, and subjects were told that they were participating in a research project.

In the data analysis, the sexes were treated separately, since pilot studies on small portions of these data indicated considerable number of sex differences in the biographical correlates of science achievement.

In the data collection, all subjects completed the measuring instruments in the same order, (1) the biographical information blank, (2) a special questionnaire dealing with their particular interests in science, and (3) a self-rating form. Other information was obtained from the permanent school records and from teachers at a later time.

Indices of Achievement. Four criteria of achievement in high school science were used. The first of these was grade point average in all science courses adjusted so that an A = 4.00, a B = 3.00, a C = 2.00, and a D = 1.00. Variation in the number of science courses taken was treated as error in the sense that no adjustments were made to correct for it. The second criterion was the score obtained at the end of the senior year of the Sequential Test of Educational Progress: Science Achievement Test. This score, in the form of a percentile rank, was obtained from permanent school records. The third criterion was a teacher rating[4] of "Overall performance as compared to a hundred randomly selected science students".

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[4] Teachers were paid for making these ratings (and other ratings collected in this research), so the authors feel their motivation was sufficient to insure careful ratings.

These scores were adjusted so that 100 was the highest possible score, and the score for each individual student was the average of the ratings given him by all instructors who had taught him in a science course. The fourth criterion was obtained from a modification of a special form, which was originally developed by the National Merit Scholarship Corporation.[5] On this form, Ss were required to respond to the following three questions.

a. What are your major interests in school?

b. In what fields in the area of science do you have the greatest interest?

c. What scientific problems do you consider to be important and of special interest to you? Do you have any notions about how these problems might be solved?

The original intention of the authors was to make detailed breakdowns of the responses obtained on this form. Unfortunately, however, the poor quality of the responses precluded this. As a result, the score of this criterion is an overall rating of "involvment with science" on a 3 point scale where 3 is the highest possible score. For each S, the score involves the average of two independent ratings. These ratings were made by two Ph.D. psychologists.

In order to provide also a score on each of these four variables with "ability" controlled a California Mental Maturity Inventory IQ was obtained for each student in our sample from the permanent school records. Scores with IQ partialled out were then computed for each S on each criterion, using the procedure and equation presented in Walker and Len (1953). The constants for this equation were obtained separately for males and females, and were based on only the students tested in 1961. (In other words, the 1961 constants were used in both the 1961 group and the 1962 group).

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[5] The authors wish to thank Dr. John Holland for granting permission to use this form.

Thus, in the present study there were eight final criteria. Four of these were the basic measures described above and four were the same measures, but with IQ held constant by means of partial correlation techniques.

Analysis of Biographical Information Blank. The techniques used in building keys for the biographical information blank were developed by Taylor and his associates (1960) and by Ellison and Taylor (1962) in adult scientist groups, and are similar to the techniques used earlier by Siegel (1956). A detailed discussion of the rationale for this technique is presented by Ellison (1960).

The basic procedure in this technique is to compute the biserial correlation between each alternative of each item in the biographical information blank and each criterion. Thus, for a five alternative item and the eight criteria described above, forty separate biserial correlations would be computed.[6] Since the 300 items of the biographical blank were predominantly five alternative items, analysis of any one group would involve computation of approximately 12,000 biserial correlation coefficients. These coefficients were then used as the basis for building empirical keys for predicting each criterion from responses to the biographical information blank.

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[6] Obviously, the computation of such a large number of biserial correlations would be impossible without the aid of large computers. Accordingly, these computations were made at Western Data Processing Center, University of California, Los Angeles.

In these empirical keys, any item alternative was included which had a correlation of .20 or higher and which was chosen by 5% or more of the sample. This arbitrary criterion was used rather than a system based on a significance test of the biserial correlation for two reasons: (1) in order to keep the procedures of this study exactly comparable to Ellison and Taylor's (1962) study of adult scientists, and (2) because the biserial correlations for the alternatives of a given item are not independent, since in most cases only one alternative per item was to be checked. Items were keyed with unit weight rather than according to a differential weighting system based on the size of the biserial correlation coefficients, since validity studies have shown little or no improvement in prediction from differential weighting of items (Guilford, 1950, pp. 537-542). This means that in these keys item alternatives correlating plus .20 or greater were given a weight of +1 and item alternatives correlating minus .20 or greater were given a weight of -1. Thus an individual's score on a given empirical key was the number of positively keyed alternatives he chose, minus the number of negatively keyed alternatives he chose (plus a constant to eliminate negative scores). In the validation and cross-validation of keys, these individual scores were correlated with the appropriate criterion scores.

A double cross-validation study was carried out for each sex separately. This means that keys for predicting the criteria built on the 1961 sample were cross-validated by applying them to the 1962 sample, and keys built on the 1962 sample were cross-validated on the 1961 sample. In addition to the cross-validities, original validities were also computed by applying the keys built on a given group to the same group. The two groups were also combined into a single large sample, keys built using the procedure described above, and original validities determined.

Results and Discussions. The male sample validities and cross-validities for predicting the four basic criteria without regard to "ability" are presented in Table 1, and for predicting the same criteria with IQ partialled out are presented in Table 2. Similarly, the female sample validities and cross-validities for the basic criteria are presented in Table 3, and for the criteria with "ability" controlled in Table 4. In previous studies of biographical blanks, no attempt has been made to construct keys for criteria with ability controlled. The reason for this is that it has generally been assumed that biographical blanks are measuring considerable criterion variance in addition to what is measured by ability tests, and that therefore a biographical blank key constructed on the raw criterion would, if it held up under cross-validation, also have substantial validities against the criterion with ability partialled out. The extra computational labor involved in obtaining a criterion with

Table 1

MALE SAMPLE: Original Validities and Cross Validities for Predicting Four Indices of Achievement in High School Science from the Biographical Information Blank

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
Index of Achievement	1961 Group	1962 Group	Combined Groups	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1. Science Grade Point Average	.85	.90	.76	.49**	.52**
2. Science Achievement Test	.81	.88	.69	.32**	.33**
3. Involvement with Science	.76	.85	.68	.29**	.24*
4. Teacher Rating of Overall Performance in Science	.79	.87	.74	.52**	.55**

Table 2

MALE SAMPLE: Original and Cross Validities for Predicting Four Indices of Achievement in High School Science when IQ is Controlled

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
Index of Achievement	1961 Group	1962 Group	Combined Groups	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1. Science GPA	.80	.88	.68	.42**	.43**
2. Science Achievement Test	.79	.92	.66	.13	.06
3. Involvement with Science	.78	.84	.66	.17	.19*
4. Teacher Rating of Overall Performance in Science	.75	.86	.66	.44**	.41**

* $p < .05$

** $p < .01$

Note: No significance level is reported for original validities because they are to an unknown degree spuriously high.

Table 3

FEMALE SAMPLE: Original Validities and Cross Validities for Predicting Four Indices of Achievement in High School Science from the Biographical Information Blank

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
Index of Achievement	1961 Group	1962 Group	Combined Groups	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1. Science GPA	.83	.85	.73	.63**	.52**
2. Science Achievement Test	.83	.83	.70	.56**	.50**
3. Involvement with Science	.80	.86	.74	.38**	.39**
4. Teacher Rating of Overall Performance in Science	.80	.84	.68	.31**	.43**

Table 4

FEMALE SAMPLE: Original and Cross Validities for Predicting Four Indices of Achievement in High School Science when IQ is Controlled

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
Index of Achievement	1961 Group	1962 Group	Combined Groups	Keys for 1961 Group Applied to 1962 Group	Keys for 1962 Group Applied to 1961 Group
1. Science GPA	.81	.85	.67	.28**	.24*
2. Science Achievement Test	.84	.86	.67	.09	.15
3. Involvement with Science	.81	.88	.72	.15	.32**
4. Teacher Rating of Overall Performance in Science	.77	.78	.61	.30**	.29**

* $p < .05$
** $p < .01$

Note: No significance level is reported for original validities since they are to an unknown degree spuriously high.

ability controlled is therefore unjustifiable. A check on the correctness of this assumption for the present study was made by cross-validating the keys built on the criteria with ability not controlled against the criteria with IQ partialled out. Results for both males and females are presented in Table 5.

The results presented in these tables are quite unequivocal, indicating that the biographical information blank is a powerful predictor of achievement in high school science. All of the original validities are characteristically (and spuriously) high. The crucial test, of course, involves the cross-validities. For the criteria without regard to IQ, the cross-validities are also very high for non-intellectual predictors, ranging from .24 to .63. All of these cross-validities are significant at the .05 level, and all but one are significant at the .01 level. Overall, then, these results are highly similar to those obtained in adult scientist groups; and therefore, indicate that the same instruments which identify good and poor scientists also identify students who do and do not achieve in science.

The cross-validities with IQ controlled are somewhat less striking, and suggest that for some criteria the correlation between the biographical inventory and achievement disappears when IQ is controlled. As is to be expected, these criteria are those involving mainly (and perhaps solely) the purely verbal skills measured by the IQ test, i.e., the Science Achievement Test

Table 5

Cross Validities for Biographical Information Blank Keys Built on Indices of Achievement with Ability not Controlled Applied to Indices of Achievement with IQ partialled out

	Index of Achievement	Male Sample Correlations		Female Sample Correlations	
		Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1.	Science GPA	.45**	.42**	.22**	.33**
2.	Science Achievement Test	.11	.18*	.13	.24*
3.	Involvement with Science	.17	.26**	.38**	.33**
4.	Teacher Rating of Overall Performance in Science	.36**	.47**	.31**	.26**

$* < .05$
$** < .01$

Table 6

Comparison of Male and Female Total Samples on Four Indices of Achievement in High School Sample

		Male $\bar{X}$	Male σ	Female $\bar{X}$	Female σ	t
1.	Science GPA	2.51	.86	2.80	.76	4.13**
2.	Science Achievement Test	72.01	23.32	50.09	26.84	10.10**
3.	Involvement with Science	1.71	.64	1.30	.45	8.78**
4.	Teacher Rating of Overall Performance in Science	58.12	21.03	60.34	29.26	1.00

** $p < .01$

criterion and the "Involvement with Science" criterion which is based on a short written composition. On the other hand, for the more complex criteria (grade average and teacher rating) the cross-validities are still substantial even when IQ is controlled. In the authors' opinion, therefore, these results overall suggest that as long as there is true score variance left in the criterion, the biographical blank will predict a significant portion of that variance.

The results for applying the keys built on the raw criteria to the criteria with IQ controlled are quite interesting and intriguing. Cross-validities for these keys against these criteria tend to be slightly higher than the cross-validities for the keys actually built on the criteria with IQ controlled. The reasons for this are not entirely clear, but are perhaps related to the effect of eliminating IQ from the criterion on the factorial complexity of the biographical items correlated with that criterion. Another explanation, which appears more parsimonious would be that when IQ is partialled out of the criterion, the relative amount of true score in that criterion is decreased. This makes it more likely that the biographical correlates of such a criterion are purely random, and therefore less likely that they will hold up on cross-validation. However, whatever the reasons for these results, the implications are quite clear. If one is building a key for a biographical blank to predict a criterion of the type used in this study, nothing is to be gained by controlling IQ. Therefore, one should simply use the raw criterion scores in deriving the key.

The results presented in these tables suggest that there are sex differences in the degree to which the various criteria can be predicted from the biographical blank. The cross-validities for the achievement test and involvement with science criteria are substantially higher in the female sample than in the male, while the cross-validities for the teacher rating criterion are noticeably higher in the male sample. This suggested the possibility that there might also be sex differences in patterns of achievement. As a check on this possibility, differences between criteria means for the two sexes (in each case combining the 1961 and 1962 groups into a single sample) were tested by means of _t_ tests. Results are presented in Table 6, and indicate highly significant differences between the sexes, on all indices of achievement except the Teacher Rating. Thus, the data confirm the presence of strong and interesting sex differences in achievement in science. It is hardly surprising that males get more involved with science than do females. However, it is puzzling to find that girls get higher grades in science, but obtain _lower_ scores on an objective test of knowledge of science. An explanation in terms of teachers favoring conformity immediately suggests itself, but no definite evidence can be presented that this explanation is correct. There is, however, a clear indication that for unknown reasons _males_ are penalized by science teachers (mostly male)" in grading" whereas females are rewarded.

An interesting portrait of high achievers in science can be constructed from the biographical correlates of that achievement. First, they correctly estimated their own high ability. In fact, the best (or at least most economical) way to find out who your top science scholars are may be to ask them. High achievers also value "money" less than "people" or "ideas". Psychological independence would be a key descriptive phrase in evaluating them. They also appear to be constructively dissatisfied with themselves, and are constantly analyzing their own work, in an apparently healthy way.

Having a reading or speaking knowledge of a foreign language is significantly related to achievement. An interest in chess is also related. Family associations with people in the academic and scientific world are quite important. Considerable reading, especially of fiction but also of non-fiction, is also related.

A most interesting characteristic of the top science students is that they are rather critical of the job their science teachers are doing and frankly consider it "rather poor" (but not "extremely poor"). It is uncertain to what degree this judgment reflects objective reality, but it does reveal an attitude of critical evaluation which they possess not only towards their teachers but toward themselves. They also tend to ask a greater than average number of questions in their classes. Finally, it is an unhealthy sign for high achievement if a students mother was less than 20 when the student was born.

A final comment should be made about the results of this study in view of this portrait. This comment is that the high achiever as revealed by the biographical inventory is a student who is familiar with the academic world, and has internalized the values of that world. This means that if the present biographical blank were used in the identification of scientific talent, it could penalize the culturally disadvantaged even more than do aptitude tests. Unlike aptitude tests, however, this is not inherent in the biographical approach. That is, one could easily apply a biographical blank in some such cultural backwater as Spanish Harlem, and determine which items discriminated high achievers from low among the culturally impoverished.

CHAPTER II-B

Creativity Tests and Their Relation to Achievement in High School Science

For many years, educational researchers were content to accept measures of achievement as meaningful in and of themselves. Recently, however, investigators have realized that there is a need for an understanding of the processes involved in achievement. One aspect of these processes, creativity, has become an increasingly popular area for educational and psychological investigation within recent years. Although part of this effort is a result of increased concern with the effective utilization of human talents and resources, it has many of the characteristics of a fad. Studies of all types have been lumped under the concept of "creativity" which seems to have ever expanding limits. However, the results of the best creativity research have suggested that many currently popular ideas about human psychology are somewhat oversimplified.

This is particularly true of current views about intellectual processes and abilities. Applied workers, both in clinical and in educational settings, tend to conceptualize the human intellect almost solely in terms of the IQ. Such a view of the intellect, of course, is implicitly or explicitly a general factor theory of intelligence similar to that of Spearman (1927), and as such has a considerable advantage in economy of conceptualization. In addition, it is supported in the clinic by behavioral observations, and in school generally by the success with which IQ tests can be used to predict school grades. This approach, however, presents difficulties when a student does either better or poorer than one would expect on the basis of his IQ. Such problem cases are typically dealt with by labeling the "offending" student an over-achiever or under-achiever and/or attributing the deviation from what would be expected on the basis of IQ to "motivational factors." Since these motivational factors are seldom identified, it may be that such an explanation is often a picturesque substitute for a lack of knowledge. It therefore provides no real information about the processes involved in science achievement.

There is an alternative approach to the intellect which until recently, has been much less influential in these areas. This approach is to conceive of the intellect as composed of a number of relatively independent, or separate capacities, or, in other words, multiple factors. In this approach, over-and under-achievement are attributed to intellectual abilities other than represented by the traditional IQ concept. This view has some advantage over explanations in terms of motivation, in that it is amenable to empirical test with existing techniques, and that it does permit drawing some inferences about processes in achievement.

The earliest investigator to apply this approach in a really systematic way was Thurstone (1938), who conceived of the intellect as composed of several "primary factors." More recently Guilford and his various associates (1950, 1951, 1953, 1955, 1957, 1959) have used a similar approach and extended and refined considerably the work of Thurstone. At the present time, Guilford's (1959) theory of the structure of the intellect involves 120 separate dimensions. Well over a hundred of these are not tapped by present day IQ tests. Thus there still remain a large number of dimensions of intellect for which tests have not yet been constructed.

Guilford feels that these dimensions may be considered functionally as well as structurally. Accordingly, there are five basic operations: cognition, memory, divergent production, convergent production, and evaluation. The content which can be employed is figural, symbolic, semantic, and behavioral, while the products of the intellect are units, classes, relations, systems, transformations, and implications. Guilford further believes that creativity (or, more properly, the creative product) is a result mainly of the divergent processes, including such things as idea production, fluencies, flexibilities, and originality.

The work of Guilford, however, has concentrated most on the analysis of the relationship between tests and has been less concerned with the relationship of these tests to such external criteria as grades. As a result, critics of this approach have stated that before these tests can be said to be an improvement on conventional IQ tests it must first be demonstrated that they (i. e. creativity tests) are valid in the sense of predicting conventional criteria, and that they account for criterion variance that is not accounted for by IQ tests. This point is well taken, although there is some evidence for the validity of creativity tests in the work of Getzels and Jackson (1959) and of Torrance (1959).

The purpose of the present study, therefore, is to provide evidence with respect to the validity of creativity tests as predictors of performance in high school science. Specifically, this portion of our research was concerned with the answers to the following three questions:

A. Does the addition of a battery of creativity tests to a conventional IQ test result in improved prediction of performance in high school science courses?

B. Does the creativity battery alone predict performance in high school science as well as, or better than, a conventional IQ test?

C. What does the creativity battery tell us about the processes involved in achievement?

Method

Subjects. The sample consisted of a total of 114 (74 males and 40 females) students from the 1961 group described previously. Ss were selected on the basis of having completed at least two courses in science beyond General Science and of having participated in an earlier study of creativity by Needham (1961). Accordingly, creativity scores were available for these students which were obtained approximately one year before the collection of the criterion data. Data was analyzed separately for males and females.

Predictor Measures. In the high school studies, the California Mental Maturity Inventory is routinely given to all entering students.

Accordingly this test was used in this study to provide an "IQ" for each S. This test has been shown to correlate highly with the Stanford-Binet Intelligence Scale.

The creativity battery consisted of the following tests developed by Guilford and was administered in the following order: Consequences, Word Association, Hidden Figures, Brick Uses, and Match Problems. The above battery is not representative of all of Guilford's creativity "elements", but rather is heavily weighted on "Ideational Fluency." It should be noted that such a weighted selection of tests reduces the factorial complexity of the battery, and therefore appears to be a conservative "error" since a reduction in factorial complexity tends to reduce validity when the criterion is complex.

On the Consequences test, Ss are required to state what would happen if certain hypothetical events occurred. An example of the type of question asked is "What would happen if all the iron ore in the world disappeared?" Two scores are obtained. The first is the number of immediate responses, a measure of "Ideational Fluency." The second is the number of statements that imply that S was thinking in terms of more remote or indirect consequences. In answer to the above question, the response "Aluminum stock would be more valuable" would be counted in this category. This score is interpreted as measuring "Originality."

On the Word Association test, Ss are required to give as many synonyms as possible for each of six words. The score is the total number of acceptable synonyms, a measure of "*Associational Fluency*."

On the *Brick Uses* test, as the name implies, *S*s are required to list as many different uses for a brick as they can. Two scores are obtained. The first is the total number of uses listed, again a measure of "*Ideational Fluency*." The second is the number of times a change in the *type* of use is made. An example would be a change from "To build a house" to "To throw at the umpire at a baseball game." This score is a measure of "*Spontaneous Flexibility*."

On the *Hidden Figures* test, *S* is given a series of simple designs paired with complex patterns. The task for *S* is to find each simple design and its accompanying complex pattern, and the score is the total number of correct responses, a measure of "*Figural Redefinition*."

On the *Match Problems* test, *S*s are given a series of drawings of groups of matches arranged to form a group of triangles. The task is to eliminate a given number of matches in such a way that a given number of triangles is left. The score is the total number of correct responses, a measure of "*Adaptive Flexibility*."

Criteria: The same four criteria described in Chapter II were used in this study, and included Science Grade Point Average, Science Achievement Test Score, a measure of Involvement with Science, and a Teacher Rating of Overall Performance in science.

Results

The means, standard deviations, inter-correlations, and validities of the predictors and the criteria means, standard deviations, and intercorrelations for both males and females are presented in Table 7.

In Table 7, correlations for males are presented below the diagonal and correlations for females are presented above the diagonal.

Multiple correlations were computed using the Fisher-Doolittle technique (Walker and Lev, 1953). These computations were made on the Burroughs 205 Datatron computer. Use of the Fisher-Doolittle technique results in a Beta weight for each predictor against each criterion in addition to multiple correlations.

Two separate analysis were made for *S*s of each sex, one of the creativity battery alone and one of the creativity battery plus IQ. Results for males are presented in Table 8, and for females in Table 9.

Discussion

The results presented in Table 8 and Table 9 clearly indicate that the tests in the creativity battery do have considerable predictive validity against each of the criteria for each of the sexes, and that the creativity tests do account for a substantial amount of criterion variance in addition to that accounted for by the IQ test. Furthermore, on all four criteria for males and two of the four criteria for females the multiple correlation for the creativity battery is higher than the first order validity of the IQ test, and on the remaining 2 criteria for females the creativity battery

Table 7

Means, Standard Deviations, Intercorrelations, and Validities of Predictors and Criteria Means, Standard Deviations, and Intercorrelations

	Predictors	1	2	3	4	5	6	7	8	9	10	11	12	$\bar{X}$ Female	σ Female	$\bar{X}$ Male	σ Male
1.	California Mental Maturity IQ	---	.41	.41	.26	.20	.38	.30	.35	.65	.49	.55	.15	99.28	11.64	101.22	11.78
2.	Word Association	.40	---	.38	.17	.04	.39	.44	.02	.29	.05	.41	-.06	18.53	6.00	14.54	5.23
3.	Hidden Figures	.39	.14	---	.02	.33	.38	.42	.37	.40	.31	.31	-.11	19.90	4.09	19.48	5.06
4.	Consequences - Immediate	.16	.08	.04	---	.23	.21	.36	.26	.21	.03	.30	.23	7.53	3.29	7.98	3.61
5.	Consequences - Remote	.37	.25	.09	.18	---	.02	.11	.17	.17	.21	.11	-.12	5.15	4.89	5.13	2.72
6.	Brick Uses - Total	.27	.27	.21	.33	.26	---	.32	.31	.21	-.14	.19	-.02	19.83	5.57	20.37	6.47
7.	Brick Uses - Change	.43	.35	.25	.10	.40	.24	---	.18	.06	.03	.32	.00	6.38	4.07	7.33	4.83
8.	Match Problems	.40	.16	.46	.03	.20	.20	.15	---	.43	.20	.38	-.06	6.75	3.71	5.63	3.21
9.	Science - GPA	.61	.27	.47	.02	.35	.24	.34	.47	---	.49	.76	.11	2.81	.80	2.38	.79
10.	STEP Science Test	.47	.43	.39	.03	.43	.13	.46	.36	.48	---	.35	.07	52.10	28.06	69.35	25.20
11.	Teacher Rating Science Potential	.43	.33	.36	.04	.24	.29	.31	.35	.63	.35	---	.02	60.62	24.48	56.97	21.82
12.	Involvement with Science	.21	.21	.15	.22	.19	.28	.06	.27	.21	.18	.18	---	1.21	.37	1.69	.65

NOTE - Correlations for Males (N=79) are presented below the diagonal and correlations for females (N=40) are above diagonal.

Table 8

Beta Weights and Multiple Correlations for Males, N=79

	Betas Without IQ				Betas With IQ			
	Science GPA	STEP Science Test	Teacher Rating Science Potential	Involvement With Science	Science GPA	STEP Science Test	Teacher Rating Science Potential	Involvement With Science
1. Word Association	.0229	.2670	.1361	.1435	.0092	.2502	.1452	.1448
2. Hidden Figures	.2987	.2629	.1565	.0546	.2099	.2457	.1542	.0581
3. Consequences - Immediate	.0452	.1151	-.0121	.2197	-.0246	.1026	-.0456	.2226
4. Consequences - Remote	.2206	.3125	.0663	.1904	.1266	.2535	.0208	.1934
5. Brick Uses - Total	.0084	-.1848	.1268	.1111	.0237	-.1812	.1343	.1105
6. Brick Uses - Change	.0860	.1724	.0998	-.1700	.0327	.1779	.0751	-.1659
7. Match Problems	.2542	.1346	.1726	.1874	.1819	.1150	.1376	.1899
8. Calif. Mental Maturity IQ	-----	-----	-----	-----	.3930	.0954	.1921	-.0092
Multiple Correlation	.63	.68	.52	.44	.70	.65	.55	.44

Table 9

Beta Weights and Multiple Correlations for Females N=40

	Betas Without IQ				Betas With IQ			
	Science GPA	STEP Science Test	Teacher Rating Science Potential	Involvement With Science	Science GPA	STEP Science Test	Teacher Rating Science Potential	Involvement With Science
1. Word Association	.2565	.0683	.3856	-.0848	.1485	-.0545	.2829	-.1598
2. Hidden Figures	.2912	.3783	.0501	-.0231	.2111	.2501	-.0055	-.0637
3. Consequences - Immediate	.2205	.1171	.1731	.2802	.1225	.0050	.1049	.2303
4. Consequences - Remote	.0550	.1066	.0553	-.0213	.0142	.0181	.0033	-.0522
5. Brick Uses - Total	-.0610	-.3386	-.1335	.0102	-.1385	-.4132	-.1810	-.0024
6. Brick Uses - Change	-.3207	-.1293	.0435	-.0339	-.2969	-.1032	.0560	-.0219
7. Match Problems	.3153	.1383	.3323	-.1161	.5278	.5004	.3661	.2672
8. Calif. Mental Maturity IQ	-----	-----	-----	-----	.2233	.0327	.2657	.1648
Multiple Correlation	.51	.47	.55	.25	.78	.55	.66	.36

predicts almost as well as the IQ test. These results are consistent with the earlier findings of Getzels and Jackson (1959) that high creativity children and high IQ children do equally well on achievement tests in spite of marked differences in IQ.

The results do provide interesting information about the processes involved in our measures of achievement. Thus for males, getting high grades in science appears to involve Figural Redefinition, Originality, and Adaptive Flexibility, but not Spontaneous Flexibility or Associational and Ideational Fluency, while for females high grades involve Associational Fluency, Figural Redefinition, Ideational Fluency, and Adaptive Flexibility, with a substantial negative contribution by Spontaneous Flexibility. Similarly a high Achievement Test score for males involves all of the processes somewhat, but especially Originality, Associational Fluency, and Figural Redefinition, and for females the most important processes are Figural Redefinition and again a strong negative weight for Ideational Fluency. For males the Teacher Rating criterion involves Associational Fluency, Figural Redefinition, Ideational Fluency, and Adaptive Flexibility; while for females this criterion involves primarily Associational Fluency and Adaptive Flexibility. For both sexes the main process in the Involvement With Science criterion appears to be Ideational Fluency especially as measured by the Consequences Test.

The results of the present study which uses a wide range of both creative and IQ abilities, as well as conventional techniques for assessing validity, offer persuasive evidence for the potential of

Guilford's approach.

These interpretations are strengthened by the time lag between the testing and the collection of criteria data. Although both IQ and creativity tests were both administered before, the lower reliability of the Guilford measures (Guilford, 1960) as opposed to the much higher ones of the California Mental Maturity Inventory give the latter considerable advantage which does not show through. In this regard, it should also be noted that a group IQ test of the type used in this study, because of its similarity in item forms and content to achievement tests, should therefore have a higher correlation with the creativity tests than would more refined IQ measures. In the opinion of the authors, therefore, this study underestimates the degree to which the creativity tests are independent of IQ.

In addition to this main contribution, this study also provides data about several important questions which were, for the purposes of this study, secondary issues. The first of these has to do with the relationship between teacher ratings and tests of IQ and creativity. Getzels and Jackson (1962) present data that suggests that teachers prefer high IQ pupils to high creativity pupils and perhaps even discriminate against high creativity pupils. Torrance (1959) also feels that high creativity pupils are less preferred by teachers. In the present study, however, there is little evidence that the teachers were penalizing high creativity pupils. The weighted combination of creativity tests predicted teacher ratings better than the IQ test alone for both sexes, and also for both sexes the addition of the creativity battery to the IQ test resulted in a substantial increase in the per cent of variance in teacher ratings accounted for.

This discrepancy between the results of these studies and the results of these earlier investigators is probably due to differences in the kinds of rating the teachers were asked to make. In the present study, the teachers were rating "performance in science," a characteristic where the "brilliant non-conformer" is unlikely to be penalized. On the other hand, in the Getzels and Jackson study ratings included (1) general desirability as a student, (2) leadership qualities, and (3) ability to become involved in learning activities. All three of these ratings appear to have a high loading on conformity, and the authors find it hardly surprising that high creativity pupils are therefore rated low on them. Needham's study (1962) found no relationship between creativity and teacher preference, measured in terms of student desirability in the classroom.

The main point of all this is that the results of Getzels and Jackson have been generalized considerably without too much supporting evidence for these generalizations. The findings of the research presented here suggest that Getzels and Jackson's results have probably been over-generalized, and that the relationship between teacher ratings and pupil intellectual characteristics is quite complex. However as with all questions in educational psychology, much more research is needed before this relationship is fully understood.

CHAPTER II-C

Relationship Between the Biographical Information Blank and Parent Attitudes

The results presented in ChapterII-A indicate that the Biographical Information Blank shows considerable validity against a variety of criteria of achievement in high school science, and that the Biographical Information Blank is accounting for a substantial amount of variance other than the variance associated with IQ. These results, therefore, confirm the results obtained by Taylor et. al. (1960) and by Ellison and Taylor (1962) which indicated that biographical information is among the best predictors of the creativity and productivity of adult scientists. The results are also consistent with those obtained by Siegel (1956) and by Kausler and Little (1957) in college populations.

All of these studies, including the present one, suggest that biographical inventories have great potential for aiding in the early discovery of scientific talent. However, all these studies have used biographical information blanks on an empirical, or trial-and-error basis, and have not explored to any great degree the characteristics which are actually measured by the biographical blank. If one is concerned only with prediction, this is not a defect, since there can be little doubt that biographical blanks are very powerful predictors indeed. On the other hand, if one is also concerned with understanding, it becomes necessary to study systematically the relationship between biographical inventories and a wide variety of other characteristics in order that one may know the kinds of inferences which can be made from biographical information.

The study reported in this chapter is a first step in this systematic investigation of the variables related to biographical blank responses. In particular, this study is related to the question of whether biographical information blanks should be interpreted as a means of gathering objective information about experiences or should be interpreted as "personality" tests in that the blanks provide information about perceptions of experiences rather than about the experiences themselves.

The particular approach chosen is to study the relationship between the biographical blank responses of a sub-sample of this high school student group and the attitudes held by their parents. This approach is derived from the theoretical position of Roe (1957) that the hereditary basis for intelligence, special abilities, etc. are relatively non-specific, but rather are determined by early experiences, especially with one's parents. Results supporting this theoretical position have been obtained by Strodtbeck (1958) and Baldwin and his associates (1945). Specifically, in the present study, measures of various parent attitudes were obtained by means of scales taken from the Parental Attitude Research Instrument, or PARI, developed by Schaffer and Bell (1955). These biographical information blank responses of children were then correlated with the attitudes of their parents in a double cross-validation design.

Sample. This study is based on sub-samples of our total group of students selected on two bases: (1) that they were living with at least one of their real parents and (2) the willingness of their parents to fill out the parent attitude scales. The sub-sample for father attitudes was slightly different from the sub-sample for mother attitudes. The father attitudes sub-sample consisted of 160 student-father pairs, of which 94 were drawn from the 1961 group and 66 from the 1962 group. In this sub-sample there were 110 male students and 50 female students. The mother attitudes sub-sample consisted of 172 student-mother pairs, 102 drawn from the 1961 group and 70 from the 1962 group. In this sub-sample, there were 118 male students and 54 female students. In the data analysis the sexes were combined, since, if the biographical information blank is to be interpreted as a means of gathering objective information about early experiences, there should be no sex differences in the biographical blank correlates of parent attitudes.

Parent Attitude Scales. The measures of parent attitudes used in the present study consisted of scales chosen from the mother and father forms of the Parental Attitude Research Instrument, or PARI, developed by Schaeffer and Bell (1955). A sub-set of scales was used instead of the complete PARI because it was felt that the length of the original PARI forms was excessive and involved much duplication.

The scales used to measure mother attitudes were chosen from the original PARI on the basis of a factor analysis done by Zuckerman and his associates (1958) which isolated three dimensions of mother attitudes as follows: (1) Authoritarian Control (2) Hostility Rejection, and (3) Democratic Attitudes. Scales were chosen to represent these three dimensions roughly in proportion to the "strength" of each factor, and therefore, included the following twelve measures: Encouraging Verbalization, Equalitarianism, Comradeship, Marital Conflict, Irritability, Rejection of the Mother Role, Seclusiveness, Breaking the Will, Martyrdom, Exclusion of Outside Influences, Deification of Parents, Suppression of Sexuality.

. Each of these scales consisted of five Likert-type attitude items with four alternative responses (Strongly Agree, Agree, Disagree, Strongly Disagree) per item. Scores were assigned so that a high score on a given scale indicated holding the type of attitude implied by the scale.

The scales used to measure father attitudes were chosen from the PARI on the basis of a pilot factor analysis[7] carried out by the authors which suggested two dimensions in father attitudes: Authoritarian Control and Democratic Attitudes. Accordingly the following eight scales were included in the measure of father attitudes:

[7] A subsequent factor analysis of the PARI using more sophisticated techniques for factor extraction and rotation indicated seven dimensions as follows: Authoritarian Control, Democratic Attitudes, Hostility -Rejection, Non-Punishment, Independence- Achievement Orientation, Male Dominance, and Seclusiveness. A detailed report of this factor analysis is presented in Appendix A.

Encouraging Verbalization, Equalitarianism, Comradeship, Breaking the Will, Exclusion of Outside Influences, Suppression of Sexuality, Suppression of Emotion, and Forcing Independence. Each scale consisted of eight items of the same type as those composing the mother attitude scales. Again scores were assigned so that a high score implied acceptance of the kind of attitude indicated by the scale name.

Data with regard to parent attitudes were collected in the following way: After the students had completed their biographical blanks, the parents of those students living with either their true father, their true mother, or both, were contacted by a research assistant trained in interviewing.[8] If the parent (or parents) was willing to participate, an appointment was made at a time when the parent (s) could be at home. If there was no time which could be arranged in the first phone call,that child-parent pair was dropped from the sample. This graduate assistant then took the two measures of parent attitudes to the appointment and waited until each parent had completed his or her entire set of attitude scales.

Procedure. The technique used in building biographical keys to predict parent attitudes was highly similar to the technique described in Chapter II for building keys to predict science achievement. Each separate parent scale (e.g., Rejection of the Mother Role) was treated as a separate criterion, and the biserial correlation was computed between each of these criteria and each alternative of each of the 300 items of the biographical information blank. Those alternatives chosen by more than 5% of the sample and correlating .20 (±) or higher with each criterian were included in the key for that criterion. A double cross-validation design was again used. In other words, one key was built on the 1961 group and cross-validated on the 1962 group, and another key was built on the 1962 group and cross-validated on the 1961 group. In addition to these cross-validities, original validities were also computed for each group by building keys on a given group, and correlating scores derived from these keys for the same group with the criteria. Finally, the 1961 and 1962 groups were combined into a single sample, keys built from this sample for predicting each criterion, and original validities for the combined groups determined.

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[8] The authors are grateful to Gary Sahleen for his assistance in collecting these data.

Results and Discussion. The original and cross-validities for predicting mother attitudes from the biographical blanks are presented in Table 10, and for predicting father attitudes in Table 11. It is obvious from these results that the original validities for each group are quite satisfactory, but that on cross-validation the keys do not hold up at all. In other words, the analytic procedures, the biographical blank, and attitude scales used in this study, did not produce stable keys for predicting parent attitudes (from the biographical blank responses of their children). In view of the results presented in Chapter IIA, it does not appear that these results can be attributed to defects in the biographical blank or in the key

Table 10

Original Validities and Cross Validities for Predicting the Attitudes of Mothers from Responses of Children to the Biographical Information Blank

	Mother Attitude Scale From PARI	ORIGINAL VALIDITIES 1961 Group	 1962 Group	 Combined Groups	CROSS VALIDITIES Key for 1961 Group Applied to 1962 Group	 Key for 196[illegible] Group Applied to 1962 Group
1.	Encouraging Verbalization	.89	.87	.75	.11	.11
2.	Equalitarianism	.91	.91	.74	-.10	-.14
3.	Comradeship	.88	.94	.78	.17	-.03
4.	Marital Conflict	.87	.88	.71	.16	.12
5.	Irritability	.86	.86	.70	.15	.08
6.	Rejection of the Mother Role	.89	.94	.75	-.07	-.17
7.	Seclusiveness	.88	.92	.78	.22	.09
8.	Breaking the Will	.86	.92	.76	-.12	.03
9.	Martyrdom	.90	.92	.74	.08	-.02
10.	Exclusion of Outside Influences	.92	.94	.74	-.02	-.15
11.	Deification of Parents	.89	.92	.75	.20	.12
12.	Suppression of Sexuality	.90	.90	.72	-.04	.00

Note: None of the cross-validities are significant at the .05 level

Table 11

Original Validities and Cross Validities for Predicting the Attitudes of Fathers from Responses of Children to the Biographical Information Blank

	Father Attitude Scale From PARI	ORIGINAL VALIDITIES 1961 Group	ORIGINAL VALIDITIES 1962 Group	ORIGINAL VALIDITIES Combined Groups	CROSS VALIDITIES Key for 1961 Group Applied to 1962 Group	CROSS VALIDITIES Key for 1962 Group Applied to 1961 Group
1.	Encouraging Verbalization	.91	.91	.75	-.08	.05
2.	Equalitarianism	.91	.93	.76	.11	.01
3.	Comradeship	.91	.94	.73	-.15	-.14
4.	Breaking the Will	.92	.90	.73	.06	.10
5.	Exclusion of Outside Influences	.90	.90	.74	-.04	.00
6.	Suppression of Sexuality	.91	.92	.80	-.09	.00
7.	Suppression of Emotion	.91	.89	.78	-.14	-.07
8.	Forcing Independence	.90	.91	.83	-.18	-.12

Note: None of the cross-validities are significant at the .05 level building procedure, and the reliabilities of the parent attitude scales are sufficiently high (Zuckerman, et. al., 1958; Cline, et. al., 1963) to render flaws in the criteria an implausible explanation of the results. It should be noted that the various response sets affecting attitude scales of this type should make attitudes *more* predictable rather than less, since these sets would tend to increase scale reliability. In sum these results strongly suggest that the Biographical Information Blank should *not* be interpreted as a measure of objective information about early experiences, but rather should be viewed as a special type of personality test measuring perceptions of one's early life experiences.

Several additional steps had been planned for this study of the *PARI* on the assumption that it would be possible to build stable biographical keys for predicting parent attitudes. One such planned step was to determine the extent to which the manifest content of the biographical items corresponded to the parental attitude correlates of the same items by having expert judges (i. e., psychologists) sort biographical items into categories corresponding to the parent attitude scales and computing indices of agreement between the judges' sorts of biographical items and the corresponding parent attitude correlates. A second planned step was to score biographical blanks using the keys for predicting parent attitudes and then to compute a multiple correlation between these scores and the various measures of achievement in high school science. Since it proved impossible to construct stable biographical keys for predicting parent attitudes, it is clear that these subsequent steps would be meaningless. They were therefore, not carried out.

Several concluding remarks should be made about these results for parent attitudes. First, the failure to find stable relationships between childrens' statements about their backgrounds and independent measures of those backgrounds does _not_ imply the conclusion that when a person makes a statement about his background, his statement is _necessarily_ in error. If that were actually the case, high negative correlations would have been found between biographical items with a given content and corresponding parent attitudes. Thus the implication is that when a person makes a statement about his background, you cannot tell whether he is giving accurate or inaccurate information from the mere fact of the statement itself. All you know is that he perceives things in a certain way; his perceptions may be right or wrong.

Secondly, these results do not mean that biographical blanks are useless for predicting other criteria. Our earlier results clearly indicate considerable utility for predicting achievement in high school science. However, these results do indicate that the relationship between the content of biographical items and criteria with which those items are correlated cannot be interpreted in a straight forward way. The actual processes and characteristics tapped by the biographical items remain obscure. Again it should be pointed out that as long as one is concerned only with prediction and is satisfied with the level of prediction attained for criteria of achievement in high school science, this is an irrelevant matter. On the other hand, the authors feel strongly that further progress in the use of biographical blanks, either for prediction or for increasing our knowledge about man, does _require_ that we strive for understanding rather than be content with trial and error discovery of covariation between measures. Therefore, there is considerable need for further systematic investigation of what is involved in responses to biographical blanks, in order that the use of such blanks may be put on a much firmer theoretical base.

CHAPTER II-C

Factor Analysis of Self Ratings, Teacher Ratings,
and
Indices of Achievement in High School Science

In Chapter II-A evidence was presented that biographical inventories show considerable promise as predictors of achievement in high school science, and in Chapter II-B data relevant to the question of what processes are involved in such achievement. It was felt, however, that much additional information is needed about the dimensions and correlates of high achievement in the science curriculum before a full understanding can be obtained of the processes related to competence.

In attempting to locate and understand highly talented persons, there appear to be three kinds of information which have traditionally been used, (1) Objective Tests, (2) Ratings and Evaluations by teachers, supervisors, etc., and (3) Self Ratings and Evaluations. Of these three types of information, objective tests have undoubtedly been investigated most frequently. However, there is a growing body of evidence that this emphasis on tests has resulted in neglecting other important types of information. For example, Campbell (1960) has recently suggested that an important indicator of test validity should be that "test scores predict independent trait-appropriate or criterion measures better than do self-ratings" and pointed out that the available evidence (Campbell and Fiske, 1959) suggests that only rare existing tests can be considered valid by this criterion. Similarly, Taylor and his associates (1961) have shown that self-ratings are among the best predictors of the on-the-job performance of physical scientists, and that conventional tests of aptitude and personality are among the worst predictors. Also, Torrance (1959) has shown that pupils high on *both* IQ and creativity are rated by their teachers as being talkative, quick to think of an idea if something goes wrong with plans, having unusual but sound ideas, and getting attention from peers for their ideas more often than are pupils high on either IQ or creativity alone, a set of findings certainly providing information about the "dynamics" of these high profile types not fully provided by their test scores.

In view of these results (and many other similar studies), it was decided to explore the factor structure of various indices of achievement in high school science and also self and teacher ratings of characteristics which presumably are related to such achievement.

Sample. The sample consisted of the 1961 group, and an additional group of 65 students who completed the criterion data but not the biographical inventory and therefore were not included in previous analyses. In this sample there were 222 males and 174 females.

Design. The two sexes were treated as separate groups. For each group, all variables were intercorrelated and factor analyzed using the factor technique based on eigenvalue analysis (Harmon, 1960), and rotated to a final solution using the varimax rotation procedure. All factors having an eigenvalue greater than one were retained and rotated; and unity was placed in the diagonal cells of the correlation matrix. All computations were made on the IBM 7090 computer.[9]

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[9] Again these computations were made through the courtesy of the Western Data Processing Center, University of California, Los Angeles, California.

Variables Studied. Four objective indices of achievement in high school science were included. The first of these was grade point average in all high school science courses adjusted so that A = 4.00, B = 3.00, C = 2.00, and D = 1.00. The second was the score on the STEP Science Achievement Test. These scores, in the form of percentile ranks, were obtained from the permanent school records. The test was administered at the end of the Senior year. The third index of achievement was the total number of science courses taken. This data was collected in the final semester of the senior year of these students. The fourth was based on the responses of the subjects to the following three questions:

a. What are your major areas of interest in school?

b. In what fields in the area of science do you have the greatest interest?

c. What scientific problems do you consider to be of special interest to you? Do you have any notions about how these problems might be solved?

The original intention was to make detailed breakdowns of the responses obtained. Unfortunately, however, the very poor quality of the responses precluded this. As a result the score on this variable is an overall rating of "involvement with science" on a three point scale where 3 is the highest possible score. For each subject, the score involves the average of two independent ratings, one by each of two Ph.D. psychologists.

In addition, a group of five teacher ratings (closely related to science achievement) were included. The first two of these, on a five category scale, were ratings of potential for success as (1) a science teacher, and (2) a research scientist. The second two were ratings on a three category scale of (3) likelihood that the student will follow a career in science, and (4) the degree to which the teacher would like to have the student as an assistant on an important scientific research project. The fifth was a rating of where the student would fall in a group of 100 randomly selected science students in terms of his overall performance. For each student, the score on each rating variable involved the average of ratings given by all teachers who had taught him in science courses. Variation in the number of teachers rating students was treated as error in the sense that no attempt was made to correct for it.

Two variables were included to evaluate the relation of intellectual characteristics to achievement in science courses. The first of these was a _California Mental Maturity Inventory_ IQ (obtained from permanent school records) and the second, a teacher rating on a three category scale of "Amount of Potential Used."

Finally, self and teacher ratings on a four category scale, were obtained on forms originally developed by the National Merit Scholarship Corporation. The self rating form included the following twenty characteristics: emotional stability, originality, leadership, popularity, athletic ability, dependability, drive to achieve, scholarship, sociability, aggressiveness, neatness, self-control, independence, conservatism, practical mindedness, expressiveness, cheerfulness, self-confidence, self-understanding, and perseverance. The teacher rating form[10] was identical with the exception that "emotional stability" was replaced with "overall general ability."

Results and Discussion. The means, standard deviations, and communalities of the variables for both sexes are presented in Table 12 and the intercorrelations are presented in Table 13 with correlations for males appearing below the diagonal and correlations for females above the diagonal. The final rotated factors, eigenvalues, and cumulative variance accounted for after extraction of each factor for both females and males are presented in Table 14. In Table 14, the sign of the factor loadings is exactly as printed out by the computer. It will be seen that in several cases, a better approximation to positive manifold could be attained by reflecting factors.

These results reveal considerable complexity of factorial structure, a finding in contrast with the results of Wolins and McKinney (1961) who found only three factors in their investigation of achievement in science. In the present study, eight factors were found for males and nine factors for females. This discrepancy, no doubt, is a function of the greater variety and number of variables included in our study. The factors obtained in this study are named and/or described as:

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[10] The original plan in this research was to obtain teacher ratings by modifying a checklist such as the one developed by Dr. Don Taylor (1957) for measuring creativity in scientific researchers. The authors subsequently decided to use the National Merit Scholarship Corporation forms instead, since they are designed specifically for high school students, and sample not only the characteristics evaluated on the Taylor form but also numerous additional characteristics.

Table 12

Means, Standard Deviations, and Communalities of Variables

		Females $\bar{X}$	σ	h^2	Males $\bar{X}$	σ	h^2
1.	Grades in Science Courses	2.76	.80	.67	2.20	.75	.72
2.	Science Achievement Test	50.36	27.69	.61	67.35	25.70	.61
3.	Number of Science Courses	3.30	1.33	.74	4.51	1.85	.60
4.	Involvement with Science	1.19	.36	.54	1.66	.65	.58
5.	Teacher Rated Potential as Science Teacher	3.01	1.05	.85	2.82	1.01	.81
6.	Teacher Rated Potential as Research Scientist	2.81	1.05	.86	2.73	1.04	.83
7.	Teacher Rated Likelihood of Science Career	1.52	.57	.66	1.76	.64	.81
8.	Teacher Rated Desirability as Research Assistant	2.15	.79	.81	1.92	.73	.82
9.	Teacher Rated Overall Performance in Science	60.36	24.52	.84	55.12	21.80	.85
10.	IQ	101.76	11.55	.63	100.08	12.46	.56
	TEACHER RATINGS						
11.	Teacher Rated Amount of Potential Used	2.36	.60	.55	2.08	.59	.69
12.	Overall General Ability	2.53	.78	.83	2.33	.72	.79
13.	Originality	2.43	.68	.79	2.21	.65	.79
14.	Leadership	2.40	.73	.83	2.12	.64	.82
15.	Popularity	2.55	.66	.71	2.30	.57	.78
16.	Athletic Ability	2.26	.53	.63	2.20	.55	.62
17.	Dependability	2.60	.73	.80	2.27	.76	.78
18.	Drive to Achieve	2.52	.81	.82	2.14	.81	.85
19.	Scholarship	2.57	.80	.85	2.18	.81	.87
20.	Sociability	2.62	.67	.71	2.29	.54	.72
21.	Aggressiveness	2.42	.73	.70	2.17	.66	.74
22.	Neatness	2.70	.65	.66	2.26	.62	.69
23.	Self Control	2.48	.65	.78	2.28	.60	.78
24.	Independence	2.53	.68	.76	2.33	.59	.72
25.	Conservatism	2.39	.55	.74	2.20	.50	.72
26.	Practical-Mindedness	2.42	.59	.76	2.27	.55	.78
27.	Expressiveness	2.53	.71	.78	2.11	.64	.77
28.	Cheerfulness	2.65	.68	.70	2.41	.56	.63
29.	Self-Confidence	2.44	.76	.78	2.24	.71	.76
30.	Self-Understanding	2.29	.64	.77	2.09	.64	.84
31.	Perseverance	2.44	.72	.82	2.21	.71	.82
	SELF RATINGS						
32.	Emotional Stability	2.65	.77	.58	2.59	.68	.52
33.	Originality	2.51	.70	.63	2.59	.71	.57
34.	Leadership	2.44	.74	.60	2.43	.72	.65
35.	Popularity	2.30	.68	.72	2.35	.66	.65
36.	Athletic Ability	2.26	.92	.59	2.52	.79	.77

Table 12 (Continued)

		Females			Males		
		X	σ	h^2	X	σ	h^2
37.	Dependability	3.00	.77	.60	2.81	.73	.61
38.	Drive to Achieve	2.70	.76	.66	2.49	.72	.54
39.	Scholarship	2.62	.86	.67	2.49	.82	.58
40.	Sociability	2.64	.76	.72	2.57	.66	.63
41.	Aggressiveness	2.38	.74	.61	2.46	.68	.61
42.	Neatness	2.85	.79	.63	2.62	.75	.60
43.	Self Control	2.80	.79	.64	2.72	.72	.44
44.	Independence	2.91	.76	.57	2.85	.71	.50
45.	Conservatism	2.43	.67	.62	2.36	.68	.55
46.	Practical Mindedness	2.64	.69	.71	2.64	.66	.62
47.	Expressiveness	2.55	.76	.62	2.41	.73	.72
48.	Cheerfulness	2.88	.76	.60	2.69	.71	.63
49.	Self-Confidence	2.29	.85	.75	2.49	.79	.55
50.	Self-Understanding	2.60	.86	.69	2.54	.66	.55
51.	Perseverance	2.58	.76	.63	2.50	.69	.58

Table 13

Intercorrelations of Variables
for both Males and Females

	1	2	3	4	5	6	7	8	9	10	11
1. Grades	--	48	18	21	67	68	45	64	64	48	53
2. Achievement Tests	48	--	37	19	40	37	32	34	35	54	36
3. Number of Courses	35	48	--	35	16	14	05	14	16	38	15
4. Involvement	26	23	33	--	13	09	13	13	18	15	12
5. Science Teacher	67	43	26	28	--	92	49	84	86	43	64
6. Research Scientist	71	44	28	25	90	--	49	83	86	36	60
7. Career in Science	70	44	26	27	76	81	--	60	47	33	41
8. Research Assistant	70	41	24	22	85	85	80	--	73	39	60
9. Overall Performance	70	48	32	23	82	83	77	81	--	38	67
10. IQ	57	53	35	24	43	42	45	41	39	--	46
11. Potential Used	60	39	29	15	61	62	63	62	73	31	--
Teacher Ratings											
12. Overall General Ability	71	47	32	27	81	81	71	72	79	47	59
13. Originality	62	34	24	22	75	77	68	70	79	37	62
14. Leadership	60	36	19	20	69	66	56	58	69	36	55
15. Popularity	47	31	16	09	58	52	42	46	56	34	44
16. Athletic Ability	20	18	09	04	34	29	19	23	28	12	16
17. Dependability	69	36	31	27	72	71	64	72	78	34	72
18. Drive to Achieve	72	46	33	25	76	77	75	76	85	36	75
19. Scholarship	81	44	29	27	81	80	77	79	86	44	70
20. Sociability	44	18	10	05	60	56	46	50	61	28	47
21. Aggressiveness	51	34	23	16	64	64	56	60	68	38	54
22. Neatness	55	30	24	09	62	62	50	56	65	32	59
23. Self Control	54	28	17	08	59	57	49	53	60	17	60
24. Independence	52	33	15	13	67	67	53	58	68	36	59
25. Conservatism	46	23	13	04	50	51	41	45	56	24	56
26. Practical-Mindedness	59	32	19	22	73	71	58	67	78	35	60
27. Expressiveness	60	33	24	24	73	73	62	66	73	40	55
28. Cheerfulness	48	27	15	06	55	54	46	52	57	28	53
29. Self-Confidence	58	33	25	20	70	68	62	67	75	38	61
30. Self-Understanding	64	28	21	14	72	70	65	70	75	28	67
31. Perseverance	64	37	24	21	73	73	71	76	81	34	75
Self Ratings											
32. Emotional Stability	25	09	09	12	17	18	26	19	12	20	17
33. Originality	20	22	10	10	18	21	21	20	22	19	09
34. Leadership	31	23	02	05	36	33	27	29	34	20	26
35. Popularity	12	06	02	-03	19	15	08	12	17	08	11
36. Athletic Ability	02	01	-02	-02	08	06	-02	06	07	-02	03
37. Dependability	25	05	09	05	14	15	12	15	14	05	12
38. Drive to Achieve	33	20	13	18	30	28	26	25	30	18	21
39. Scholarship	63	32	17	28	55	56	52	56	56	41	44
40. Sociability	14	11	05	-05	17	16	10	13	15	09	02
41. Aggressiveness	16	21	10	06	18	19	17	15	16	13	10
42. Neatness	03	-03	-01	-13	-06	-02	-05	-01	-02	00	-05
43. Self Control	13	07	01	06	07	07	10	10	09	10	00
44. Independence	12	24	11	04	11	16	14	11	15	23	11
45. Conservatism	18	09	06	14	19	17	16	19	18	25	15
46. Practical Mindedness	33	27	19	20	34	32	34	30	33	26	21
47. Expressiveness	21	19	03	16	22	25	25	23	23	18	08
48. Cheerfulness	09	25	-05	01	13	09	18	16	14	01	06
49. Self-Confidence	09	05	-01	00	14	15	17	13	12	09	07
50. Self-Understanding	14	07	-04	02	13	17	22	18	15	15	10
51. Perseverance	16	07	04	03	20	16	13	13	19	10	05

	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
1. Grades	68	62	52	48	30	62	64	71	49	44	46	43	52	45	50	48	41	52	51	61
2. Achievement Tests	41	33	32	29	03	38	39	45	28	22	30	35	29	26	31	40	23	30	24	37
3. Number of Courses	19	17	17	12	-05	10	19	20	09	08	13	15	18	07	15	25	09	16	13	20
4. Involvement	15	12	12	04	03	10	16	14	08	08	12	10	07	06	13	20	09	08	06	17
5. Science Teacher	79	74	71	61	46	71	77	75	65	57	55	60	62	59	66	64	55	66	66	74
6. Research Scientist	80	74	68	59	50	69	76	79	61	53	51	61	62	58	69	61	51	62	66	76
7. Career in Science	48	42	31	32	05	40	48	46	31	85	22	24	22	16	30	30	24	30	27	28
8. Research Assistant	70	66	61	55	39	64	70	72	55	47	43	51	48	47	58	52	51	57	55	65
9. Overall Performance	85	78	71	61	47	73	78	82	67	58	54	62	63	62	68	69	61	68	72	76
10. IQ	43	38	32	32	05	35	40	45	33	29	24	29	37	30	28	39	27	33	27	34
11. Potential Used	58	54	53	40	30	61	70	59	49	46	43	52	49	45	53	55	51	53	60	63
Teacher Ratings																				
12. Overall General Ability	--	87	77	65	46	75	82	87	68	61	55	63	68	67	69	74	61	69	74	79
13. Originality	90	--	81	66	50	72	76	84	68	67	58	62	73	67	69	77	62	77	72	75
14. Leadership	74	70	--	79	57	68	75	73	72	76	57	63	71	58	70	77	64	79	70	74
15. Popularity	59	57	81	--	60	61	69	64	77	64	60	60	61	50	62	69	69	72	59	62
16. Athletic Ability	38	32	56	60	--	42	51	42	64	53	39	43	48	42	48	49	48	51	45	46
17. Dependability	71	71	65	51	35	--	83	80	61	55	60	70	66	64	70	65	58	66	70	82
18. Drive to Achieve	78	81	70	58	34	80	--	83	66	64	57	65	66	62	69	71	64	73	72	84
19. Scholarship	86	79	72	58	30	77	87	--	64	58	60	64	66	66	69	72	62	70	74	79
20. Sociability	60	60	75	76	53	59	59	57	--	65	49	56	62	52	58	71	73	68	60	60
21. Aggressiveness	67	70	77	73	48	58	71	67	68	--	47	51	73	49	54	71	52	75	58	64
22. Neatness	67	66	65	60	36	69	69	67	63	60	--	73	60	63	66	62	64	60	65	64
23. Self Control	64	64	63	53	37	73	70	66	58	57	73	--	69	75	78	66	65	68	75	73
24. Independence	71	76	71	61	44	64	71	68	60	72	68	67	--	74	68	71	60	77	69	77
25. Conservatism	58	61	64	53	38	64	61	58	55	55	69	73	72	--	79	60	57	65	72	73
26. Practical-Mindedness	71	79	68	55	38	73	75	74	63	61	70	73	77	72	--	67	60	65	77	79
27. Expressiveness	79	77	74	64	37	68	75	78	63	73	58	65	72	62	72	--	70	73	70	71
28. Cheerfulness	51	59	62	63	38	63	60	56	68	61	60	67	56	59	61	62	--	70	65	64
29. Self-Confidence	74	75	72	65	41	67	78	76	65	79	63	63	73	59	69	80	66	--	75	73
30. Self-Understanding	71	77	72	64	38	76	83	79	63	72	69	76	72	68	78	79	66	82	--	79
31. Perseverance	71	78	66	56	31	79	86	81	57	69	69	66	73	63	74	74	61	77	83	--
Self Ratings																				
32. Emotional Stability	16	16	12	12	-05	24	22	18	08	13	22	18	19	14	13	15	20	13	13	20
33. Originality	23	22	22	20	12	17	22	19	22	24	18	06	24	12	14	20	20	17	10	16
34. Leadership	35	31	48	47	31	30	35	30	44	37	33	31	37	29	28	32	36	30	28	30
35. Popularity	24	17	37	43	33	16	18	16	36	27	26	19	25	25	15	21	24	20	19	15
36. Athletic Ability	08	04	16	27	28	03	06	05	15	15	10	01	11	01	-01	05	09	10	04	01
37. Dependability	17	15	15	18	04	20	23	20	16	19	18	21	17	19	14	13	25	14	18	19
38. Drive to Achieve	32	24	33	29	11	34	30	29	29	28	30	25	28	26	25	25	29	28	23	28
39. Scholarship	58	49	51	45	24	57	57	59	45	48	48	45	51	40	52	53	40	47	51	54
40. Sociability	17	13	34	38	23	07	15	12	30	26	15	08	18	13	11	19	23	17	13	09
41. Aggressiveness	16	11	29	26	17	13	17	11	22	26	11	01	13	10	06	15	15	18	14	15
42. Neatness	02	-06	09	19	13	00	-01	-04	11	09	09	-02	05	06	-07	01	06	04	00	04
43. Self Control	03	01	06	20	00	10	08	06	00	05	06	01	06	00	01	01	05	04	05	08
44. Independence	11	09	18	16	06	05	13	10	14	18	04	-05	12	00	-01	08	04	09	03	08
45. Conservatism	15	15	14	15	04	19	19	18	10	12	21	16	18	12	17	13	15	11	12	13
46. Practical Mindedness	33	26	39	37	16	32	32	32	29	26	31	25	29	21	32	32	30	27	26	25
47. Expressiveness	23	27	24	21	09	13	16	19	24	22	14	09	16	11	19	21	29	23	17	17
48. Cheerfulness	10	09	24	24	17	12	14	10	21	17	11	14	15	14	06	05	17	13	14	12
49. Self-Confidence	10	13	24	27	14	09	14	08	21	22	14	06	12	06	09	13	20	12	10	12
50. Self-Understanding	10	13	15	18	01	12	19	14	15	16	25	09	17	08	10	10	18	09	08	13
51. Perseverance	16	11	21	26	11	16	18	18	20	28	11	09	19	10	11	18	13	11	09	11

	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51
1. Grades	16	13	18	02	-12	23	34	62	07	01	09	05	08	10	13	20	-05	09	15	19
2. Achievement Tests	07	04	16	-01	-13	25	27	45	04	02	01	04	10	11	12	24	-06	-01	07	07
3. Number of Courses	-04	17	21	12	-02	11	11	29	18	07	12	08	11	09	04	12	00	08	16	07
4. Involvement	20	21	20	09	01	23	21	23	11	11	16	11	11	17	22	20	10	13	06	16
5. Science Teacher	07	18	31	14	-02	24	26	59	12	09	02	05	06	05	07	20	-09	14	13	18
6. Research Scientist	03	12	23	11	-03	19	23	55	06	02	03	02	04	03	08	19	-15	11	12	12
7. Career in Science	06	-02	07	-01	-08	08	19	30	08	04	01	04	07	-01	-05	07	-01	06	01	03
8. Research Assistant	05	09	20	07	-09	13	19	47	08	01	01	04	03	05	08	11	-11	08	07	09
9. Overall Performance	07	13	29	13	-01	27	28	58	11	09	03	04	07	05	10	19	-07	11	14	20
10. IQ	02	05	21	-07	-08	19	18	45	-02	06	-09	-06	03	00	03	11	-15	-07	-01	08
11. Potential Used	09	08	19	07	-04	30	28	47	05	06	07	03	12	12	13	17	-06	09	19	16
Teacher Ratings																				
12. Overall General Ability	12	12	27	13	-09	30	29	57	10	09	05	10	12	04	10	22	-05	13	14	15
13. Originality	14	16	29	20	-10	32	33	55	18	14	12	15	20	04	13	25	02	17	10	20
14. Leadership	12	29	42	25	01	25	34	51	20	20	10	14	27	07	16	23	05	17	11	28
15. Popularity	07	20	38	24	-05	23	31	44	21	13	08	13	20	06	11	20	02	14	11	23
16. Athletic Ability	03	21	27	25	08	12	17	33	08	00	11	-01	09	00	07	13	10	23	09	22
17. Dependability	17	-02	25	04	-13	28	34	55	06	-05	04	15	03	09	07	10	-08	16	10	17
18. Drive to Achieve	09	06	31	08	-09	26	33	57	07	03	01	06	07	09	05	14	-08	11	14	16
19. Scholarship	12	07	25	10	-11	28	31	62	03	01	02	06	09	02	11	20	-11	[illegible]	[illegible]	16
20. Sociability	05	18	33	24	02	26	29	49	15	18	07	07	16	02	12	24	08	18	13	25
21. Aggressiveness	-01	23	35	22	04	13	22	37	20	20	07	03	25	00	09	25	09	17	09	17
22. Neatness	06	06	26	14	-18	19	23	40	13	10	13	08	04	09	10	19	-06	14	14	19
23. Self Control	10	04	20	08	-17	24	26	36	08	07	06	07	08	04	09	08	-06	07	11	15
24. Independence	05	14	24	12	-10	25	28	44	11	07	05	02	17	-04	11	22	01	23	09	15
25. Conservatism	00	09	13	-01	-09	22	22	37	01	01	01	00	08	02	12	13	-06	10	08	12
26. Practical-Mindedness	10	08	26	10	-11	27	25	39	09	03	09	10	10	08	15	10	-04	13	13	21
27. Expressiveness	09	17	31	22	-07	25	33	44	18	19	02	04	21	06	15	28	02	20	16	21
28. Cheerfulness	05	10	22	19	-10	22	24	35	16	18	01	01	09	05	16	15	04	09	03	15
29. Self-Confidence	06	18	32	22	-06	18	24	47	17	12	06	10	15	-02	15	17	04	15	12	23
30. Self-Understanding	08	06	21	06	-05	26	24	41	07	07	11	06	10	05	07	12	-06	13	16	24
31. Perseverance	12	09	25	08	-03	34	30	53	11	08	07	08	09	09	13	15	-03	14	12	21
Self Ratings																				
32. Emotional Stability	--	07	24	24	02	36	32	19	35	20	36	47	36	42	28	15	37	34	35	34
33. Originality	21	--	44	41	26	16	23	24	29	39	22	17	35	16	24	43	30	30	25	45
34. Leadership	28	31	--	53	16	30	40	41	38	42	28	31	37	22	22	38	27	40	26	40
35. Popularity	11	25	57	--	82	16	21	26	61	37	41	34	33	17	09	28	33	44	28	29
36. Athletic Ability	13	19	22	36	--	15	06	05	13	18	16	11	22	08	06	06	08	15	[illegible]	24
37. Dependability	34	27	31	18	-01	--	54	42	25	26	35	33	25	26	30	26	28	25	12	34
38. Drive to Achieve	31	36	43	23	10	42	--	46	21	28	29	29	35	32	36	29	16	36	26	55
39. Scholarship	34	32	45	25	11	34	53	--	16	09	22	21	18	11	21	32	04	22	28	31
40. Sociability	19	33	56	59	22	19	24	22	--	45	41	43	43	37	22	33	52	45	32	28
41. Aggressiveness	17	33	51	44	13	20	38	23	48	--	12	16	38	15	27	24	26	31	25	36
42. Neatness	16	22	38	42	13	37	37	17	42	38	--	56	38	38	32	29	44	44	34	39
43. Self Control	36	22	23	19	09	33	30	24	23	30	31	--	44	37	24	17	41	40	31	35
44. Independence	28	36	38	22	06	26	31	20	29	40	26	35	--	37	44	42	35	30	33	38
45. Conservatism	28	24	32	17	12	26	32	30	26	16	19	28	23	--	43	26	34	17	26	31
46. Practical Mindedness	41	31	35	21	13	28	47	41	34	30	23	44	32	49	--	38	36	22	30	43
47. Expressiveness	22	51	40	36	-02	25	31	30	44	38	29	30	36	25	37	--	33	35	30	35
48. Cheerfulness	19	15	45	41	13	17	29	20	44	37	25	07	24	27	34	37	--	44	48	38
49. Self-Confidence	20	34	45	34	15	25	40	23	43	48	43	07	43	23	35	38	33	--	27	46
50. Self-Understanding	37	38	28	23	08	28	31	30	27	32	44	38	36	25	34	35	33	46	--	39
51. Perseverance	33	34	36	20	17	48	42	31	32	39	41	37	28	26	30	32	26	45	39	--

Note - The Intercorrelations for the Male sample are listed below the diagonal, for the Female sample above the diagonal.

Table 14

Rotated Factor Loadings, Eigenvalues and Cumulated Proportions of Total Variance

		Males								Females								
		I	II	III	IV	V	VI	VII	VIII	I	II	III	IV	V	VI	VII	VIII	IX
	1. Grades	-71	-20	03	-37	17	-07	-01	-01	-55	00	20	04	-52	11	-09	-17	-11
	2. Achievement Test	-35	-02	10	-68	08	-03	02	05	-28	-08	47	29	-36	10	07	28	02
	3. Number of Courses	-19	-06	-02	-72	-09	-10	-07	-15	-10	03	84	06	-03	-04	13	02	-08
	4. Involvement	-15	-02	-10	-41	-02	-60	-06	15	-07	21	65	-13	-03	20	-07	-05	08
	5. Science Teacher	-63	-04	09	-18	16	-12	12	13	-74	-01	09	-14	-52	01	00	-03	-08
	6. Research Scientist	-84	-06	-06	-20	22	-07	07	15	-75	-01	06	-16	-50	02	-10	02	-09
	7. Career in Science	-76	-08	05	-20	39	-10	-01	15	-27	07	00	14	-74	-05	08	01	06
	8. Research Assistant	-81	-08	06	-14	34	-07	06	10	-64	04	05	-08	-62	02	-06	08	01
	9. Overall Performance	-87	-06	09	-20	17	-05	02	08	-79	01	07	-15	-43	04	-03	-05	-05
	10. IQ	-35	-08	01	-62	03	-03	05	21	-29	-25	42	18	-39	02	16	-30	08
	11. Potential Used	-77	-09	02	-16	18	07	-05	-18	-60	02	06	01	-39	09	-05	-18	-03
Teacher	12. Overall General Ability	-83	-06	08	-37	-01	-08	03	11	-81	02	09	-31	-39	02	02	-08	-06
Rating	13. Originality	-87	-02	03	-06	-01	-09	-02	15	-82	07	06	00	-38	06	12	-06	-03
	14. Leadership	-77	-02	31	-11	-26	-07	14	13	-84	05	05	-14	-14	12	25	-04	04
	15. Popularity	-65	-06	35	-09	-36	02	30	11	-77	05	-01	-07	-12	05	29	-04	08
	16. Athletic Ability	-39	11	27	-03	-49	00	38	07	-64	02	-13	-40	08	05	06	13	-10
	17. Dependability	-84	-19	01	-14	00	-08	-01	-13	[illegible]	12	03	06	-27	-10	-12	-19	-04
	18. Drive to Achieve	-69	-18	07	-17	08	-03	00	-01	-82	23	09	-03	-35	-03	-01	-11	00
	19. Scholarship	-69	-08	01	-21	12	-07	03	04	-81	-01	12	01	-39	00	-05	-13	-07
	20. Sociability	-70	00	29	01	-34	02	12	15	-76	-01	-05	-14	-18	09	27	-04	01
	21. Aggressiveness	-76	-08	30	-12	-22	06	[illegible]	21	-74	-07	-01	-10	-07	16	33	09	-01
	22. Neatness	-77	-18	07	-03	-20	-01	05	-11	-78	09	12	18	10	-06	01	-09	-18
	23. Self-Control	-80	-13	04	09	-22	-06	-03	-23	-84	07	10	18	08	-05	-05	-13	-01
	24. Independence	-81	-11	08	-01	-20	-01	08	08	-84	-07	08	08	28	08	-09	-04	-14
	25. Conservation	-73	-11	10	07	-33	03	-12	-17	-82	-05	06	08	10	07	-17	-10	-09
	26. Practical-Mindedness	-85	-06	-01	00	-15	-14	-05	04	-65	11	09	03	-01	00	-11	-10	-04
	27. Expressiveness	-84	-01	05	-11	-15	-07	02	15	-82	-03	15	07	-07	13	24	-06	-03
	28. Cheerfulness	-70	-14	17	06	-27	-02	-04	05	-79	02	-03	08	02	07	21	-04	13
	29. Self-Confidence	-84	01	10	-10	-12	-01	03	11	-85	00	04	00	-06	06	20	02	-03
	30. Self-Understanding	-91	-03	08	02	-07	00	-05	-05	-86	05	01	02	-02	-01	-08	-11	-08
	31. Perseverance	-89	-10	03	-08	08	04	-05	-02	-87	09	12	-01	-17	00	-07	-13	-02
Self	32. Emotional Stability	-14	-66	02	-02	15	-17	12	-03	-02	65	-08	10	-11	10	06	-33	-09
Rating	33. Originality	-12	-34	17	-11	-08	-10	06	02	-08	00	23	-44	08	40	38	01	-27
	34. Leadership	-30	-38	68	-06	-05	-03	09	03	-25	21	21	-29	-05	06	52	-23	-18
	35. Popularity	-15	-08	74	02	.6	00	22	-04	-13	41	11	-30	04	-10	59	11	-24
	36. Athletic Ability	-02	-12	19	03	-04	-02	33	-02	12	06	-04	-72	04	03	13	-17	01
	37. Dependability	-14	-69	09	-02	-19	11	-22	02	-22	34	11	-11	-03	09	06	-63	-03
	38. Drive to Achieve	-23	-61	24	-16	-14	-09	-07	09	-34	22	06	-08	-09	20	16	-68	-14
	39. Scholarship	-65	-42	11	-19	00	-18	06	09	-45	07	30	-19	-38	04	05	-55	-24
	40. Sociability	-08	-14	75	-01	-09	-08	09	14	-08	58	08	03	-05	09	57	11	-16
	41. Aggressiveness	-06	-22	66	-22	07	13	-02	25	-08	08	-04	-01	02	20	69	-28	-07
	42. Neatness	06	-47	49	-03	-18	31	-02	-01	-03	69	14	-10	07	11	03	-05	-27
	43. Self-Control	03	-60	21	-03	14	-12	05	07	-02	76	05	-05	-03	-01	13	-16	-13
	44. Independence	01	-33	40	-28	13	09	-06	-09	-07	39	02	-06	-02	49	38	-14	-03
	45. Conservation	-11	-47	21	05	05	-51	-07	-09	-08	80	10	00	-04	45	-06	-15	12
	46. Practical Mindedness	-34	-58	25	-13	-02	-43	11	11	-09	26	03	00	05	75	-03	-24	-05
	47. Expressiveness	-13	-24	45	02	-02	-29	-29	53	-12	07	18	-05	-12	62	24	00	-33
	48. Cheerfulness	-09	-16	68	19	13	-29	-05	-04	06	52	-08	00	07	36	29	08	-30
	49. Self-Confidence	-07	-37	48	04	04	16	04	37	-11	36	-03	-10	02	05	26	-09	-72
	50. Self-Understanding	-11	-51	21	15	20	03	05	41	-07	28	01	03	-06	80	08	-14	-73
	51. Perseverance	-07	-64	20	-03	-08	13	13	29	16	24	00	-29	08	34	18	-45	-34
	Eigenvalue	20.24	5.74	2.70	1.78	1.29	1.18	1.08	1.04	19.01	6.25	2.47	1.89	1.56	1.35	1.19	1.11	1.01
	Cumulated Proportion of Total Variance	.58	.74	.82	.87	.93	.84	.87	1.00	.58	.70	.77	.83	.87	.91	.94	.97	1.00

Female Factor I: This factor is clearly a Teacher Rating Halo, since it has high loadings on all teacher ratings. The high loading for science grades tends to confirm this interpretation, since grades can be interpreted as a special type of teacher rating.

Female Factor II appears to be a Self Rating Halo. Highest loadings are on self-ratings on emotional stability, sociability, neatness, self-control, conservatism, and cheerfulness.

Female Factor III is Involvement with Science since it has its highest loadings on number of science courses and identification with science.

Female Factor IV appears to be Athletic Ability, with high loadings on both self and teacher ratings of athletic ability. However, the relatively high loading for self ratings of originality is somewhat puzzling.

Female Factor V appears to involve Academic Achievement in Science Courses, with loadings on science grades, Science Achievement Test, and all teacher ratings of scientific performance. The relatively high loading for IQ and the relatively low loadings for "Number of science courses" and "Involvement with Science" suggest that, following the distinction of Getzels and Jackson (1961) these achievers are intelligent rather than creative.

Female Factor VI is not entirely clear, but is probably Practical Mindedness. Highest loadings are on self-ratings of Practical Mindedness, Independence, and Expressiveness.

Female Factor VII has loadings which suggest that it involves

Social Dominance. Highest loadings are on self ratings of Leadership, Originality, Popularity, Aggressiveness, and Sociability.

Female Factor VIII involves Academic Motivation with highest loadings on self-ratings of Dependability, Drive to Achieve, Scholarship and Perseverence.

Female Factor IX involves Self Confidence with high loadings on self ratings of Self-confidence and Self-understanding.

Male Factor I corresponds to the first factor in the female sample, and is most appropriately called Teacher Rating Halo. It has high loadings on all teacher rating variables, with the exception of rated "Likelihood that the student will follow a career in science."

Male Factor II is a Self Rating Halo, with highest loadings on self ratings of Emotional Stability, Dependability, Drive to Achieve, Self Control, Practical Mindedness, Self Understanding, and Perseverence.

Male Factor III involves Sociability with high loadings on self ratings of Leadership, Popularity, Sociability, Aggressiveness, and Cheerfulness, and a relatively high loading on the teacher rating of popularity.

Male Factor IV is similar to the fifth factor in the female group and represents Academic Achievement in Science. Its highest loadings are on IQ, Science Grades, Science Achievement Test, and Number of Science Courses.

Male Factor V involves the Teacher Stereotype of the Scientist Role. It has a positive loading on teacher rated "Likelihood that the student will follow a career in Science," and negative loadings on teacher ratings of Popularity and Athletic Ability. In interpreting this factor, the low loadings for the direct measures of science achievement should be especially noted.

Male Factor VI appears to be an Involvement with Science Factor, since its highest loading is on the Involvement with Science score. Other high loadings are on self ratings of Conservatism and Practical Mindedness, which suggest that an alternative name for this factor is Practical Mindedness.

Male Factor VII is Athletic Ability with highest loadings on self and teacher ratings of Athletic Ability.

Male Factor VIII might most appropriately be called Self Rated Creativity. Its highest loadings are on self ratings of Originality, Expressiveness, and Self-Understanding.

In the opinion of the authors these results have demonstrated that meaningful factors can be extracted from various tests and measures of high school science achievement, and that these factors provide valuable information about the processes of achievement. While there is considerable overlap in the factors extracted for the male and female sexes separately, the sex differences which also appear are most important. For example, while both sexes have "teacher" and "self" rating halos for Factor I and II, only the boys have a Self Rated Creativity factor and only the girls have a separate Self Confidence Factor. Furthermore, if we examine the second factors for the males and females we note that though they are called by the same name, (Self Rating Halo) there are differences in the variables which comprise their make up. In Factor II self ratings of Cheerfulness, Popularity, Sociability load highly on the female factor but not especially high on the male, and self ratings on Dependability, Perseverance, Practical Mindedness and Self Understanding appear strongly in the male factor but not so strongly in the female. In any event, a review of the data suggests that the "self" and "other" ratings of ones performance continue to be among the most important and significant kinds of information we can obtain about the performance and characteristics of students and in some cases may even be more important than standard achievement tests and/or grades.

CHAPTER II-E

The Biographical Information Blank and the Prediction of the Factor Criteria of Achievement in High School Science

In the preceeding chapter, factor criteria of a variety of aspects of students performance in the high school program, including achievement in science, were developed. Many of these criteria appear to be of a non-intellectual character. To what extent these criteria can be predicted from the biographical information blank is a most interesting question. Accordingly, the final step in this research was to develop empirical biographical blank keys for predicting these factor criteria in a double cross-validation design.

Sample. The Ss for this study were identical with the sample in the study using the four indices of achievement in science as criteria except for the addition of 76 students from a third Salt Lake City high school who were tested during the 1961 collection. Within this additional group there were 29 males and 46 females. Thus our total sample is divided into two groups, 305 females and 314 males. The sexes were treated separately in the data analysis. This additional group was excluded from the analysis reported in Chapter II-A because no Science Achievement Test score was available for them.

Criteria. The criteria for this study were based on the factors obtained from the analysis of self ratings, teacher ratings, and indices of achievement in high school science reported in Chapter II-D. Thus, for males the criteria included the following eight factor scores, Teacher Rating Halo, Self-Rating Halo, Sociability, Academic Achievement in Science, Teacher Stereotype of the Scientist Role, Involvement with Science, Athletic Ability, and Self Rated Creativity; and for females the criteria included the following nine factor scores, Teacher Rating Halo, Self-Rating Halo, Involvement with Science, Athletic Ability, Academic Achievement in Science, Practical Mindedness, Social Dominance, Academic Motivation, and Self-Confidence. Individual scores on each factor were computed by combining, with unit weight, scores on the variables with the highest loadings on that factor. In those cases in which the variables loading on a factor involved quite different scales (such as IQ and Science Grades which are part of the "Academic Achievement in Science" factor), scores on each variable were transformed to a common scale before combining them to obtain a factor score. Details of the procedures used in computing factor scores are presented in Appendix B.

Procedure. Once again, the basic procedure was to build empirical biographical blank keys for each criterion, including in the key item alternatives correlating .20 or higher with that criterion and chosen by 5% of the sample or more. Again a double cross-validation design was used in which the 1961 key was cross-validated on the 1962 group and vice versa. Original validities were again computed for the 1961 group, the 1962 group , and the two groups combined into a single sample.

Since the results obtained in the study of the four basic indices of achievement in science indicated that nothing is to be gained from partialing ability (as measured by IQ) out of criteria when building biographical blank keys, no analysis was made of the criteria with ability controlled.

Results and Discussion. The original and cross-validities for males are presented in Table 15 and the original and cross-validities for females are presented in Table 16. Once again the results are quite clear cut, and indicate that a biographical information blank is a very powerful predictor for quite diverse criteria since the median cross-validity was .40. Indeed these cross-validities for the most part are as high as those obtained in the most successful previous investigations of biographical blanks.

Overall, the results of our whole investigation offer strong support for the notion that excellence in science studies is related to more than just intelligence. There are many roads to "Rome"--that is many roads or reasons underlying excellence in the science area. The family background (e.g. educational level of parents, occupation of father, but not such things as strictness in child rearing) and social milieu in which the child is raised have a tremendous impact on his attitudes toward education, his motivation in science studies, and probably his selection of a science area as a career. The question then arises, if family climate, subculture and early training are of key importance in directing a boy or girl to a later career in science, how can interested adults increase the

Table 15

MALE SAMPLE: Original Validities and Cross Validities for Predicting Factor Criteria from the Biographical Information Blank

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
Factor Criterion	1961 Group	1962 Group	Combined Groups	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1. Teacher Rating Halo	.75	.84	.68	.49**	.34**
2. Self Rating Halo	.81	.82	.70	.46**	.44**
3. Sociability	.81	.87	.74	.54**	.53**
4. Academic Achievement in Science	.76	.83	.64	.28**	.26**
5. Teacher Stereotype of the Scientist Role	.71	.87	.56	.17	.13
6. Involvement with science	.76	.80	.58	.05	.05
7. Athletic Ability	.74	.86	.67	.30**	.24**
8. Self Rated Creativity	.79	.84	.72	.48**	.49**

* $p < .05$
** $p < .01$

Note: No significance level is reported for original validities because they are to an unknown degree spuriously high.

Table 16

FEMALE SAMPLE: Original and Cross Validities for Predicting Factor Criteria from the Biographical Information Blank

	ORIGINAL VALIDITIES			CROSS VALIDITIES	
	1961 Group	1962 Group	Combined Groups	Key for 1961 Group Applied to 1962 Group	Key for 1962 Group Applied to 1961 Group
1. Teacher Rating Halo	.76	.81	.62	.43**	.31**
2. Self Rating Halo	.73	.79	.63	.45**	.30**
3. Involvement with Science	.75	.84	.67	.47**	.36**
4. Athletic Ability	.76	.79	.68	.40**	.40**
5. Academic Achievement in Science	.76	.83	.65	.54**	.35**
6. Practical Mindedness	.73	.82	.67	.61**	.33**
7. Social Dominance	.75	.83	.69	.58**	.38**
8. Academic Motivation	.78	.83	.72	.62**	.51**
9. Self-Confidence	.74	.81	.65	.48**	.40**

** $p < .01$

Note: No significance level is reported for original validities because they are to an unknown degree spuriously high.

interest of youth in pursuing such careers? This, of course, is a difficult question to answer. But, in part, it is related to the pattern of folk heroes which we present to our youth. Too frequently, some have argued, these "folk heroes" have been hip swinging crooners, exceptionally well coordinated athletes, or even TV or motion picture personalities exceptionally skilled in fisticuffs, and meting out mayhem and violence. Maybe what is needed is a new breed of heroes, a new kind of Horatio Alger, a new kind of pioneer on the frontier, which our youth might identify with, and this might be a man who uses intelligence, reason, and the tools of science to subdue matter, not his striated muscles.

CHAPTER III

Conclusions and Implications

1. Biographical information on the Biographical Information Blank (BIB) proved to be a powerful predictor of achievement in high school science for both original and cross validities. In other words the same type of instruments which predict for adult scientists also work as well or better for high school students in the science area.
2. When IQ is partialled out of the "Science Achievement Criteria" the results are less striking in predicting (as in 1 above) from the BIB, which suggests (as might be expected) that the science achievement criteria in part is related to kinds of verbal skills that are also measured by IQ. Despite this however, the cross validities--even with IQ partialled out--are still substantial and especially for "grade point average in science courses" and teacher ratings of "Science aptitude and potential" of the student. The implications in reviewing these results are that nothing is gained by partialling out IQ in this kind of predictive study.
3. In the cross validities the BIB keys predict the Science Achievement Test and "Involvement with Science" criteria better for females than males.
4. In the cross validities the BIB keys predict teacher ratings of "Science Potential" better for males than females.

5. While girls obtain higher grades in science courses than boys, they obtain lower scores on objective tests of science knowledge, suggesting the possibility of a "sex effect" and the rewarding of "conformity" by the mainly male teachers in their grading.
6. Significant sex differences are found not only in the patterns of achievement but also in the intellectual characteristics related to achievement.
7. Creativity Tests (such as those developed by Guilford) can and do predict achievement in high school science and to a substantial degree independently of IQ. Furthermore, these tests do increase our knowledge of the processes involved in achievement in science.
8. Contrary to the findings of such investigators as Getzels and Jackson, there is little or no evidence suggesting that teachers discriminate against highly creative students in their ratings or grading.
9. The original validities for predicting mother and father attitudes (on the PARI) from the biographical data given by their children are satisfactory. However on cross validation these do not hold up at all. The evidence strongly suggests that it is not possible to build stable keys for predicting parent attitudes from the biographical blank responses of their children. Thus, even though the BIB is a powerful predictor of excellence for both high school science as well as for mature adult scientists, one cannot tell whether a given student on a given item is giving accurate or inaccurate

life history information about himself and parents. All one knows is that he perceives things in a certain way and that this perception may or may not be distorted. However the same thing is true for such empirically developed personality inventories as the MMPI. The keys predict regardless of whether the information given is accurate or not in relation to real life.

10. In a factor analysis of self ratings, teacher ratings, and varied indices of achievement in high school science, nine factors were found for the females: I Teacher Rating Halo, II Self Rating Halo, III Involvement with Science, IV Athletic Ability, V Academic Achievement in Science Courses, VI Practical Mindedness, VII Social Dominance, VIII Academic Motivation, and IX Self Confidence.
11. In a factor analysis of the same variables, eight factors were found for males: I Teacher Rating Halo, II Self Rating Halo, III Sociability, IV Academic Achievement in Science, V Teacher Stereotype of the Scientist Role, VI Involvement with Science, VII Athletic Ability, and VIII Self Rated Creativity.
12. The results suggest that "self" and "others" ratings of ones performance continue to be among the most significant kinds of information we can obtain about the performance and characteristics of students and in some cases may even be more important than standard achievement tests and/or grades.
13. Factor criteria of science achievement for both males and females were highly related in original and cross validities to the Biographical Information Blank data (keys).

14. The results of the whole study offer strong and convincing support to the notion that excellence in science studies is related to more than just intelligence--and that these "other" correlates differ very significantly for males vs. females.

REFERENCES

Andry, R. G. Faulty paternal and mother-child relationships, affection, and delinquency. Brit. J. Delinq., 1957, 8, 34-48.

Baldwin, A. L., Kalhorn, Joan, and Breese, Fay H. Paterns of parent behavior. Psychol. Monogr., 1945, 58, 31 (whole No. 268).

Bandura, A. and Walters, R. H. Adolescent aggression. New York: Ronald, 1959.

Bass, B. M. Authoritarianism or acquiescence? J. abnorm. soc.Psychol., 1955, 51, 616-623.

Bittner, R. H., Quantitative predictions from Qualitative data: Predicting college achievement from Biographical information. J. of Psychol., 1945, 19, 97-108.

Campbell, D. T. Recommendations for APA test standards regarding construct, trait, or discriminant validity. Amer. Psychologist, 1959, 15, 546-553.

Campbell, D. T. and Fiske, D. W. Convergent and discriminant validation by the multitrait-multimethod matrix. Psychol. Bull., 1958, 55, 328-333.

Cline, V. B., Richards, J.M., Jr., and Needham, W. E. A Factor analytic study of the Father Form of the parental attitude research instrument. Psychol. Record, 1963, 13, 65-72.

Cureton, E. E. Validity, reliability, and baloney. Educ. psychol. Meas., 1950, 10, 94-96.

Ellison, R. L. The relationship of certain biographical information to success in science. Unpublished M.A. thesis, University of Utah, 1960.

Ellison, R. L. and Taylor, C. W. The development and cross-validation of a biographical inventory for predicting success in science. Paper read at American Psychological Association, St. Louis, 1962.

Freeman, R. and Grayson, H. Maternal attitudes in schizophrenia. J. abnorm. soc. Psychol., 1955, 50, 45-52.

Getzels, J.W. and Jackson, P.W. The highly intelligent and the highly creative adolescents: A summary of some research findings. In C. W. Taylor (Ed.) *1959 Conference on the identification of creative scientific talent*. Salt Lake City: University of Utah Press, 1959.

Getzels, J.W. and Jackson, P.W. *Creativity and intelligence* New York: Wiley, 1962.

Gleuck, S. and Gleuck, Eleanor, *Unraveling juvenile delinquency*. New York: Commonwealth Fund, 1950.

Goldsmith, D. B. The use of the personal history blank as a salesmanship test. *J. appl. Psychol.*, 1922, *6*, 149-154.

Gough, H. G.; Hall, W. B.; and Harris, R. E. Admissions procedures as forecasters of performance in medical training. Paper read at First Annual Conference on Research in Medical Education, Los Angeles, 1962.

Guilford, J. P. Creativity. *Amer. Psychologist*. 1950, 5, 444-454.

Guilford, J. P., Wilson, R. C., Christensen, P. R. and Lewis, D. S. A factor analytic study of creative thinking. I. Hypotheses and description of tests. *Rep. Psychol. Lab.* Los Angeles: University Southern Calif., 1951.

Guilford, J. P. The relation of intellectual factors to creative thinking in science. In C. W. Taylor (ed.) *1955 Conference on the identification of creative scientific talent*. Salt Lake City: University of Utah Press, 1956a.

Guilford, J. P. Basic traits in intellectual performance. In C. W. Taylor (Ed.) *1957 Conference on the identification of creative scientific talent*. Salt Lake City: University of Utah Press, 1958b.

Guilford, J. P. Intellectual resources and their value as seen by scientists. In C. W. Taylor (Ed) *1959 Conference on the identification of creative scientific talent*. Salt Lake City: University of Utah Press, 1959.

Guilford, J. P. *Fundamental statistics in psychology and education, 2nd Edition*, New York: McGraw-Hill, 1950.

Guilford, J. P. *Fundamental Statistics in psychology and education*, 3rd Edition. New York, McGraw-Hill, 1956.

Hansen, P. J. The relationship of certain biographical information to the academic and behavioral adjustment of high school boys. Unpublished doctoral dissertation, University of Utah, 1950.

Harmon, H. H. *Modern factor analysis*. Chicago: Univer. of Chicago Press, 1960.

Kausler, D. H. & Little, N. D. The BIS dependency scale and grades in psychology courses. *J. counsel. Psychol*., 1957, *4*, 223-224.

Kornhauser, A. W. & McMurray, R. N. A scientific procedure for the selection of salesmen. *J. appl. Psychol*.,1941, *24*, 11-17.

Kurtz, A. K. Recent research in the selection of life insurance salesmen. *J. appl. Psychol*., 1942, *25*, 11-17.

L'Abate, L. The personality of problem parents. Paper read at American Psychological Association, Chicago, 1956.

Lidz, T., Parker, Beulah, and Cornelison, Alice. The role of the father in the family environment of the schizophrenic patient. *Amer. J. Psychiat*., 1956, 113, 126-132.

Madoff, J. M. The attitudes of mothers of juvenile delinquents toward child rearing. *J. consult. Psychol*., 1959, 23, 518-520.

Mark, J. The attitudes of the mothers of male schizophrenics toward child behavior. *J. abnorm. soc. Psychol*., 1953, *45*, 185-189.

Needham, W. B. *Biographical predictors of creativity, intelligence, and teacher preference in a high school*. Unpublished Master's thesis. University of Utah, 1962.

Ohmann, O. A. A report of research on the selection of salesmen at the Toronto Manufacturing Company. *J. Appl. Psychol*., 1942, *25*, 18-29.

Richards, J. M., Jr., & Taylor, C. W. Predicting academic achievement in a college of medicine from grades, test scores, interviews, and ratings. *Educ. psychol. Meas*., 1961, *21*, 987-994.

Richards, J. M., Jr., Taylor, C. W., and Price, P. B. The prediction of medical intern performance. *J. appl. Psychol*., 1962, *46*, 142-146.

Roe, Anne. A psychological study of eminent biologists. *Psychol. Monogr*., 1951, *65*, No. 14 (Whole No. 331).

Roe, Anne. A psychological study of eminent psychologists and anthropologists, and a comparison with biological and physical scientists. *Psychol. Monogr*., 1953, *67*, No. 2 (Whole No. 287).

Roe, Anne. Early determinants of vocational choice. *J. couns. Psychol*., 1957, *4*, 212-217.

Sanford, R. N., Adkins, Margaret M., Miller, R. B., and Cobb, Elizabeth. Physique, personality, and scholarship. *Monogr. Soc. Res. Child Developm.*, 1943, 8, No. 1.

Schaeffer, E. S. Converging conceptual models for maternal behavior and for child behavior. Paper read at conference on research on parental attitudes and child behavior, Social Science Institute, Washington University, St. Louis, 1960.

Schaeffer, E. S., and Bell, R. Q. Development of a parental attitude research instrument. *Child Developm.*, 1958, 29, 339-361.

Schaeffer, E. S. and Bell, R. Q. Father form of a parental attitude research instrument. Personal communication, 1960.

Shoben, E. J. The assessment of parental attitudes in relation to child adjustment. *Genet. Psychol. Monogr.*, 1949, 39, 101-148.

Siegel, L. A biographical inventory for students: II. Validation of the instrument. *J. appl. Psychol.*, 1956, *40*, 122-126.

Sorenson, G. *Non-intellectual Factors related to success in college.* Unpublished doctoral dissertation, University of Utah, 1950.

Spearman, C. *The abilities of man.* New York: Macmillan, 1927.

Stein, M.I., A transactional approach to creativity. In Taylor, C.W. (Ed.) *1955 Research Conference on the Identification of Creative Scientific Talent.* Salt Lake City: Univ. of Utah Press, 1956.

Strodtbeck, F. L. Family interaction, values, and achievement. In McClelland, D.C. (Ed.), *Talent and society*, New York: D. Van Nostrand, 1958.

Taylor, C. W., Smith, W. R., Ghiselin, B., and Ellison, R. S. *Explorations in the measurement and prediction of contributions of one sample of scientists.* USAF, AFSC, Personnel Lab, Lackland AFB, ASD-TR-61-96, 1961.

Taylor, D. W. Variables related to creativity and productivity among men in two research laboratories. In C. W. Taylor (Ed.) *1957 Research conference on the identification of creative scientific talent.* Salt Lake City: Univ. of Utah Press, 1958.

Thurstone, L. L. Primary Mental Abilities. *Psychol. Monogr.* 1938, No. 1.

Torrance, E. P. Explorations in creative thinking in the early school years, A progress report. In C.W. Taylor (Ed) *1959 Conference on the identification of creative scientific talent.* Salt Lake City: University of Utah Press, 1959.

Walker, Helen, and Lev. J. Statistical inference. New York: Holt, 1953.

Wolins, L. and McKinney, A.C. Factor analysis of high school science achievement measures. J. Educational Research, 1961, 54, 173-177.

Zuckerman, M., Riback, Beatrice, Monashkin, I., and Norton, J. Normative data and factor analysis on the parental attitude instrument. J. consult. Psychol., 1958, 22, 165-171.

Zuckerman, M., Oltean, Mary, and Monashkin, I. The parental attitudes of mothers of schizophrenics. J. consult. Psychol., 1958, 22, 307-310.

APPENDIX A

A FACTOR ANALYTIC STUDY OF THE FATHER FORM OF THE PARENTAL ATTITUDE RESEARCH INSTRUMENT

The relationship between child behavior and the behavior and attitudes of parents is a most important problem for theories of personality and their development. Since this is true, a considerable number of empirical investigations have been made of the structure of parental attitudes and behavior. Early investigations of such phenomena utilized primarily observational techniques. Examples of such studies are those by Sanford, Adkins, Miller, and Cobb (1943) of ratings of maternal behavior and the work of Baldwin, Kalhorn, and Breese (1945) using the Fels Parent Behavior Rating Scale.

Although these early investigations provided fruitful and important data, they also suggested that systematic observation is a prohibitively expensive technique for large scale investigations of parent attitudes. It became apparent that there was a vital need for easily administered objective measures of such variables. To meet this need, Shoben (1949) developed a pencil and paper measure of parent attitudes and conducted research which showed that such measures of the attitudes of parents are, in fact, related to the behavior of their children. Other studies by Mark (1953) and Freeman and Grayson (1955) have also substantiated the adequacy of such measures.

More recently, Schaeffer and Bell (1955) have developed the Parental Attitude Research Instrument, whose items are modeled after the earlier instruments developed by Shoben and by Mark, but which samples parent attitudes more broadly. Separate forms of the Parental Attitude Research Instrument (or PARI) have been developed for mothers (Schaeffer and Bell, 1955) and for fathers (Schaeffer and Bell, 1960). Considerable research has been conducted using the mother form (Schaeffer and Bell, 1958, L'Abate, 1956; Zuckerman, Riback, Monashkin, and Norton, 1958; Zuckerman, Oltean, and Monashkin, 1958; Madoff, 1959; and Schaeffer, 1960). The results of this research confirm the usefulness of the PARI for studying both the structure of parent attitudes and the relationship between parent attitudes and child behavior.

However, other recent research (Gleuck and Gleuck, 1950; Lidz, Parker and Cornelison, 1956; Andry, 1957; Bandura and Walters, 1959) has indicated that studies of the relationship of parent attitudes and behavior to child behavior should include measures for both mother and father. Unfortunately, however, little research has been done on the father form of the PARI which would lay a solid foundation for its use in such investigations. The purpose of the present research, therefore, is to present data concerning the scale reliabilities, scale intercorrelations, and factor structure of the father form. A particular goal is to determine to what degree the factor structure for father attitudes is comparable to the factor structure for mothers as found by Zuckerman and his associates (1958).

PROCEDURE

Measure

The father form of the PARI consists of 30 eight-item scales. Items are arranged in cyclical order, one item from each of the 30 scales in sequence, then the next item from each of the scales, and so on. Thus, the first item represents a scale which is next represented in item 31, then 61, 91 etc. Each scale attempts to measure an attitude of fathers which in theory is relevant to the personality development of their children and, for the most part, scales on the father form correspond to similar scales on the mother form. However, the mother form consists of only 23 scales, seven fewer than for the fathers. The items are general statements of opinion about child rearing, and Ss are asked to agree or disagree strongly or mildly with these statements on a four-point scale. The names of the 30 scales can be found in Table 17 . In each case, scales have been named so that the name indicates a tendency to Agree with a given type of statement. This requirement made it necessary to change the name originally given to a few scales.

Since little research has been done on the father form of the PARI, the items making up the scales, in many cases, have technical flaws such as being "double-barreled" which reduce their usefulness. Accordingly, the first step in the present research was to edit and revise items. An effort was made to keep the content of each revised item unchanged, but to express that content in a more appropriate form. Approximately 20% of the items were modified.

Sample

The sample was composed of 69 adult males recruited from a variety of sources including (1) an Adult Education night class at the University of Utah in the "Psychology of Personality," (2) a daytime Child Psychology Class at the University of Utah and, (3) a P.T.A. group at a Salt Lake City Elementary School. Ss were given a packet containing the attitude scales, an instruction sheet, and a stamped addressed envelope for returning the completed questionnaire to the authors, and were told to complete the questionnaire at their leisure. The Ss included in this group represent a return of a little less than 50%. It is obvious, therefore, that there are limitations on the degree to which this sample is representative of the populations they were drawn from, and it is probable that it does not include too many persons having attitudes strongly divergent from conventional middle-class norms. However, Zuckerman and his associates (1958), in their investigation of the mother form of the PARI, found that the factor structure remained essentially constant over various samples, including such unrepresentative groups as mothers of emotionally disturbed children and adults. This strongly suggests that sample limitations do not prevent the results of the present investigation from having some meaningfulness and reliability.

Factor Analysis

Scores from 1 to 4 were assigned to responses to each question of each scale in such a way that a high score indicates possession of the kind of attitude implied by the scale name. Each scale score is the sum of the scores on the 8 items composing that scale.

These scale scores were intercorrelated and factor analyzed on the IBM 7090 computer using the factor solution based on eigenvalue analysis. These factors were then rotated, using the varimax solution.

In this analysis, unity was inserted in the diagonal of the correlation matrix, and all factors having an eigenvalue greater than 1.00 were extracted and rotated.

A Spearman-Brown reliability was computed for each scale on the basis of a first half-second half split.

RESULTS AND DISCUSSION

Means, standard deviations, and reliabilities for the 30 scales making up the father form of the PARI are presented in Table 17. For these 30 scales the median reliability is .695 and the range of reliabilities is .29 to .86. There are several things that should be noted about these reliabilities. They are based on a simple first half-second half division, and the two halves were combined with unit weight. No attempt was made to split or weigh them so as to maximize reliability. It would appear, therefore, that the coefficients presented in Table 17 are conservative estimates of the scale reliabilities. This, interpreted in view of the fact that each scale is only 8 items long, strongly suggests that these reliabilities are as high as it is reasonable to expect for instruments of this type. Certainly the large majority are of sufficient magnitude to justify use of these scales in group comparisons. The scale intercorrelations are presented in Table 18.

Seven factors had an eigenvalue greater than 1.00. The original and rotated loadings, eigenvalues, and cumulative proportion of variance accounted for these factors and the original and final communalities for the thirty scales are presented in Table 19.

Table 17

Scale Means, Standard Deviations, and Reliabilities for the Father Form of the Parental Attitude Research Instrument

	Scale	$\overline{X}$	σ	Reliability
1.	Encouraging Verbalization	13.52	3.31	.59
2.	Fostering Dependency	24.84	3.55	.64
3.	Seclusiveness	23.51	3.04	.78
4.	Breaking the Will	26.68	3.25	.68
5.	Harsh Punishment	24.41	4.23	.71
6.	Deception	24.59	4.19	.70
7.	Marital Conflict	17.49	3.64	.84
8.	Equalitarianism	12.45	2.94	.47
9.	Non-punishment	26.48	3.16	.70
10.	Demanding Activity	20.23	4.01	.75
11.	Expressing Affection	15.13	2.55	.29
12.	Irresponsibility of Father	21.61	4.17	.82
13.	Suppression of Aggression	24.59	3.04	.53
14.	Deification of Parent	21.61	4.42	.80
15.	Exclusion of Outside Influences	25.04	3.71	.75
16.	Irritability	21.80	3.86	.68
17.	Strictness	18.45	4.50	.86
18.	Suppression of Sexuality	26.83	3.34	.75
19.	Ascendancy of Husband	19.93	5.16	.82
20.	Comradeship	13.71	3.03	.68
21.	Inconsiderateness of Wife	19.38	4.05	.66
22.	Avoidance of Expressing Affection	24.86	3.16	.63
23.	Avoidance of Communication	26.06	3.17	.65
24.	Autonomy of Child	13.68	3.10	.62
25.	Achievement Demand	17.29	4.19	.74
26.	Complaints of Ascendancy of Wife	21.65	4.08	.72
27.	Suppression of Emotion	22.14	4.43	.80
28.	Change Orientation	11.88	3.82	.69
29.	Forcing Independence	20.81	3.34	.53
30.	Past Orientation	12.58	3.31	.60

Table 18

Scale Intercorrelations (N=69) for the PARI Father Form

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1. Encouraging Verbalization	--																													
2. Fostering Dependency	-.02	----																												
3. Seclusiveness	-.04	.39	----																											
4. Breaking the Will	-.32	.30	.33	----																										
5. Harsh Punishment	-.39	.18	.25	.66	----																									
6. Deception	-.08	.21	.02	.32	.25	----																								
7. Marital Conflict	.06	.13	.02	.32	.27	.29	----																							
8. Equalitarianism	.44	-.16	.14	-.21	-.19	-.12	.03	----																						
9. Non-punishment	.27	.27	.17	-.14	-.41	.05	-.09	.03	----																					
10. Demanding Activity	.06	.22	.13	.28	.21	.14	.22	.08	.13	----																				
11. Expressing Affection	.21	.14	.19	-.13	-.14	.00	-.12	.38	.15	.08	----																			
12. Irresponsibility of Father	.08	.40	.22	.32	.17	.13	.35	-.12	.28	.21	-.07	----																		
13. Suppression of Aggression	-.10	.29	.21	.17	.17	.08	-.03	-.16	.19	.20	-.07	.13	----																	
14. Deification of Parent	-.19	.40	.28	.34	.33	.33	.06	-.10	.00	.43	.16	.16	.43	----																
15. Exclusion of Outside Influences	-.33	.65	.43	.42	.35	.34	.07	-.17	.13	.31	.17	.18	.37	.66	----															
16. Irritability	-.19	.29	.12	.42	.38	.33	.58	-.24	.09	.30	-.14	.56	.09	.17	.30	----														
17. Strictness	-.23	.23	.30	.40	.44	.18	.13	.12	-.20	.37	.09	.14	.27	.53	.38	.21	----													
18. Suppression of Sexuality	-.30	.40	.34	.58	.50	.21	.24	-.20	.17	.43	-.06	.34	.50	.58	.45	.45	.46	----												
19. Ascendancy of Husband	-.31	.19	.28	.32	.35	.19	.10	-.09	-.12	.31	.09	.24	.22	.52	.45	.29	.60	.38	----											
20. Comradeship	.39	.01	.27	-.11	-.18	-.09	.09	.57	.10	.34	.39	-.03	-.07	.18	.04	-.12	.21	.05	.17	----										
21. Inconsiderateness of Wife	-.09	.25	.30	.31	.18	.07	.30	.06	.13	.31	.07	.50	.26	.30	.35	.41	.28	.44	.51	.21	----									
22. Avoidance of Expressing Affection	-.26	.20	.17	.50	.28	.20	.36	-.24	.12	.23	-.23	.31	.11	.03	.28	.43	.21	.45	.26	-.13	.37	----								
23. Avoidance of Communication	-.23	.42	.24	.61	.55	.33	.25	-.28	.03	.36	.02	.26	.41	.30	.46	.38	.31	.57	.27	-.22	.37	.42	----							
24. Autonomy of Child	.47	-.09	-.17	-.13	-.11	.06	.35	.23	.05	.17	.10	.06	-.16	-.20	-.38	.04	-.10	-.21	-.30	.13	-.03	.07	-.05	----						
25. Achievement Demand	.01	.07	.10	.29	.25	.01	.36	.23	-.09	.61	.02	.12	.14	.41	.25	.19	.50	.44	.23	.39	.29	.30	.16	.09	----					
26. Complaints of Ascendancy of Wife	-.15	.36	.26	.32	.15	.23	.11	-.09	.14	.32	.07	.37	.25	.51	.52	.31	.38	.50	.63	.14	.73	.39	.31	-.12	.25	----				
27. Suppression of Emotion	-.13	.31	.36	.44	.18	.07	.11	-.01	.17	.50	.09	.30	.30	.34	.39	.23	.49	.49	.35	.21	.45	.50	.46	-.03	.53	.38	----			
28. Change Orientation	.09	-.35	-.53	-.43	-.21	-.09	-.14	-.08	-.16	-.38	-.17	-.39	-.18	-.26	-.34	-.31	-.43	-.37	-.44	-.23	-.37	-.38	-.31	.02	-.27	-.33	-.60	----		
29. Forcing Independance	-.08	.32	.39	.44	.42	.17	.36	-.04	.02	.57	.05	.29	.17	.33	.32	.37	.51	.44	.36	.23	.42	.50	.52	.15	.55	.35	.67	-.50	----	
30. Past Orientation	-.29	-.22	-.08	-.10	.00	-.20	-.13	-.07	-.41	-.28	-.14	-.37	-.14	-.06	-.10	-.12	-.07	-.19	-.07	-.09	-.23	-.25	-.24	-.25	-.13	-.30	-.23	.16	-.30	----

Table 19

Original and Rotated Factor Matrix, Communalities, Eigenvalues, and Cumulative Proportion of Variance for the PARI Father Form

		Original								Rotated							
		I	II	III	IV	V	VI	VII	h^2	I	II	III	IV	V	VI	VII	h^2
1.	Encouraging Verbalization	.28	.70	-.24	.13	.21	.01	.03	.68	.15	.56	-.18	.48	.01	.24	-.16	.68
2.	Fostering Dependency	-.55	.02	.06	.45	.24	.12	.22	.63	-.56	-.02	.08	.31	.00	-.12	.44	.63
3.	Seclusiveness	-.50	.18	.29	.15	-.16	.22	.52	.74	-.19	.22	.08	.00	-.05	-.16	.79	.74
4.	Breaking the Will	-.68	-.30	-.13	-.18	.04	.16	.23	.68	-.31	-.31	-.33	-.24	-.29	-.09	.48	.68
5.	Harsh Punishment	-.56	-.43	-.04	-.40	.20	.08	.23	.75	-.38	-.27	-.33	-.51	-.25	-.00	.31	.75
6.	Deception	-.33	-.15	-.18	.08	.59	-.23	.09	.58	-.60	-.03	-.45	.00	.05	-.02	-.10	.58
7.	Marital Conflict	-.36	.08	-.60	-.31	.16	-.26	.16	.71	.00	.01	-.81	-.06	-.20	-.09	.01	.71
8.	Equalitarianism	.14	.71	.17	-.25	.03	-.09	.22	.67	.20	.78	-.03	-.02	-.11	.04	.04	.67
9.	Non-punishment	-.12	.37	-.15	.73	-.05	.16	-.14	.74	-.08	.03	.11	.83	.04	-.07	.15	.74
10.	Demanding Activity	-.56	.36	-.05	-.20	.14	.12	-.34	.64	-.21	.13	-.14	.16	-.72	-.13	.02	.64
11.	Expressing Affection	-.04	.51	.35	.11	.24	-.03	.32	.55	-.23	.66	.10	.09	.07	.01	.20	.55
12.	Irresponsibility of Father	-.52	.10	-.42	.32	-.19	-.22	.15	.66	-.04	-.13	-.46	.38	-.01	-.43	.32	.66
13.	Suppression of Aggression	-.44	-.09	.21	.29	.14	.21	-.36	.52	-.46	-.24	.26	.25	-.32	-.13	.06	.52
14.	Deification of Parent	-.63	.00	.44	.01	.37	-.17	-.20	.80	-.71	.11	.11	-.11	-.35	-.37	-.01	.80
15.	Exclusion of Outside Influences	-.71	-.15	.36	.26	.24	-.03	.06	.78	-.72	-.06	.09	.01	-.15	-.35	.34	.78
16.	Irritability	-.59	-.17	-.47	.02	-.01	-.29	.15	.7	-.16	-.27	-.64	.04	-.08	-.37	.21	.70
17.	Strictness	-.64	.06	.32	-.37	.04	-.03	-.03	.65	-.30	.13	-.01	-.34	-.53	-.31	.22	.65
18.	Suppression of Sexuality	-.78	-.13	.03	.05	.02	.08	-.11	.65	-.42	-.26	-.11	.04	-.44	-.32	.32	.65
19.	Ascendancy of Husband	-.64	-.08	.33	-.09	-.18	-.42	-.03	.74	-.26	.00	.00	-.26	-.22	-.73	.17	.74
20.	Comradeship	-.11	.76	.26	-.22	-.01	-.10	.06	.72	.09	.76	.04	.05	-.32	-.14	.07	.72
21.	Inconsiderateness of Wife	-.65	.18	-.05	.12	-.34	-.41	-.06	.75	-.02	.01	-.22	.16	-.24	-.75	.22	.75
22.	Avoidance of Expressing Affection	-.57	-.14	-.42	-.01	-.32	.14	-.07	.65	.09	-.45	-.33	.14	-.37	-.23	.35	.65
23.	Avoidance of Communication	-.68	-.25	-.16	.08	.22	.29	.04	.69	-.49	-.37	-.24	.07	-.32	.02	.38	.69
24.	Autonomy of Child	.12	.46	-.58	-.19	.23	.05	-.02	.65	.21	.27	-.53	.27	-.20	.32	-.19	.65
25.	Achievement Demand	-.53	.34	.01	-.51	.00	.08	-.34	.77	-.03	.16	-.14	-.11	-.83	-.16	-.01	.77
26.	Complaints of Ascendancy of Wife	-.67	.07	.13	.22	-.16	-.46	-.18	.79	-.28	-.02	-.07	.16	-.21	-.80	.09	.79
27.	Suppression of Emotion	-.71	.22	.04	-.04	-.27	.35	-.15	.77	-.05	-.08	-.05	.17	-.67	-.22	.48	.77
28.	Change Orientation	.64	-.24	-.06	-.03	.31	-.18	-.31	.68	.02	-.10	.08	-.07	.30	.27	-.71	.68
29.	Forcing Independance	-.73	.21	-.16	-.25	-.05	.25	-.01	.72	-.12	-.01	-.28	-.03	-.66	-.11	-.42	.72
30.	Past Orientation	.31	-.38	.34	-.35	-.15	-.05	.17	.53	.16	-.07	.25	-.62	.23	.06	-.04	.53
	Eigenvalue	8.60	3.26	2.49	2.19	1.44	1.38	1.29									
	Cumulative Proportion of Total Variance	.42	.57	.69	.80	.87	.94	1.00									

NOTE: All values rounded to two decimals. Minor discrepancies between communalities and sums of factor loadings due to fact that computer works to five decimal places.

The results reveal considerable complexity of factorial structure, but factors whose interpretation is reasonably clear. The seven factors extracted and rotated are named and described briefly below.

Factor I appears to involve Authoritarian-Control. Its highest loadings are on Fostering Dependence, Deception, Deification of the Parent, and Exclusion of Outside Influences. It thus is somewhat similar to the first factor of the mother form of the PARI found by Schaeffer and Bell (1958) and by Zuckerman and his associates (1958). In contrast to these studies of the mother form, however, this first factor does not appear to be a massive general factor. This suggests that a general response set to the test was less important in our sample than in the female samples studied previously.

Factor II is highly similar to the third factor for the mother form of the PARI found both by Schaeffer and Bell and by Zuckerman, and has its highest loadings on Encouraging Verbalization, Equalitarianism, Expressing Affection, and Comradeship. In order to correspond to Zuckerman's terminology, this factor should be called Democratic Attitudes.

Factor III is similar to the second factor of the mother form found by previous investigators, with highest loadings on Marital Conflict, Irritability, and Autonomity of Child. Again after Zuckerman, this factor should be called Hostility-Rejection.

Factor IV could most appropriately be called Non-Punishment, with a high positive loading on the Non-Punishment of children scales and high negative loadings on Harsh Punishment and Past Orientation.

Since only three factors were found for the mother form of the PARI, obviously no mother factor was comparable to this or succeeding father factors.

Factor V involves favorable attitudes toward teaching children to achieve, control their emotions, and be independent. Its highest loadings are on Demanding Activity, Strictness, Achievement Demand, Suppression of Emotion, and Forcing Independence. The most appropriate title, perhaps, would be Independence-Achievement Orientation.

Factor VI includes attitudes that the father should be boss and wives should stay in their place. It might therefore be termed Male Dominance. Its highest loadings are on Ascendancy of Husband, Inconsiderateness of Wife, and Complaints of Wife Ascendancy.

Factor VII is not entirely clear, with a high positive loading on Seclusiveness and a high negative loading on Change Orientation. It seems to involve fathers who are threatened by the external world and therefore avoid contact with it. Therefore, Seclusiveness is perhaps the most appropriate name.

APPENDIX B

THE SCORING SYSTEM FOR THE FACTOR CRITERIA

In Chapter IV-D, of this report, the factor analysis of the criteria and indices of achievement are reported. From this analysis, there were eight male and nine female factors which were used as criteria to be predicted by the Biographical Information Inventory.

In order to get individual scores for each subject on each factor, the following procedure was used. Each factor was examined and those variables that loaded highest on the factor were used. Each individual's score on the variables designated was standardized and the average standard acore was used as his score for that factor. A correction was used for the sign of the factor loading.

It should be noted that a person's average standard score was used. In this way, if certain data were missing for a particular subject, his factor score would still be comparable to others for whom the data was complete.

This procedure is similar to that used by Taylor, et. al. (1960), with the exception that Taylor used beta scores.

Thus, on Female Factor I, the score for each individual was based on an average of the following variables: Teacher Ratings on Perseverance, Self-understanding, Practical-mindedness, Self-confidence, Leadership, Self-control, Independence, Originality, Drive to achieve, Conservatism, Expressiveness, Overall general ability, Scholarship, and Dependability.

On Female Factor II, the variables used were self ratings on Self-control, Neatness, Emotional Stability, Conservatism, and Sociability.

On Female Factor III, the variables used were Science Achievement Test score, number of science courses taken, and "Involvement with Science."

On Female Factor IV, the variables used were the teacher rating on Athletic Ability, and self ratings on Originality and Athletic Ability.

On Female Factor V, the variables used were Science GPA, and teacher ratings on Potential as a Science Teacher, Potential as a Research Scientist, Potential for a Scientific Career, and Potential as a Research Assistant.

On Female Factor VI, the variables used were self ratings on Practical Mindedness, Expressiveness, Independence, and Conservatism.

On Female Factor VII, the variables used were self ratings on Aggressiveness, Popularity, Sociability, and Leadership.

On Female Factor VIII, the variables used were self ratings on Drive to Achieve, Dependability, and Perseverance.

On Female Factor IX, the variables used were self ratings on Self-understanding and Self-confidence.

In the same manner, factor scores for the male sample were computed. On Male Factor I, the following variables were used: Teacher Ratings on Self-understanding, Perseverance, Drive to Achieve, Scholarship, Overall Performance, Originality, Practical-Mindedness, Potential as a Research Scientist, Dependability, Self-Confidence, Expressiveness, Potential as a Science Teacher, Overall General Ability, Potential as a Research Assistant, Independence, and Self-control.

On Male Factor II, the variables used were self ratings on Dependability, Emotional Stability, Perseverance, Drive to Achieve, and Self-control.

On Male Factor III, the variables used were self ratings on Sociability, Popularity, Leadership, Cheerfulness, and Aggressiveness.

On Male Factor IV, the variables used were the Science Achievement Test score, number of science courses taken, "Involvement with Science", and IQ.

On Male Factor V, the variables used were teacher ratings on Potential for a Scientific Career, Popularity and Athletic Ability.

On Male Factor VI, the variables used were "Involvement with Science," and self ratings on Conservatism, Practical-mindedness, and Neatness.

On Male Factor VII, the variables used were the self rating on Athletic Ability, and teacher ratings on Athletic Ability and Popularity.

On Male Factor VIII, the variables used were self ratings on Originality, Expressiveness, Self-understanding, and Self-confidence.